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BOTANY.—*New plant names published by Luigi Castiglioni.*

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A very interesting but much neglected work on early American history in general and especially on the flora of eastern North America was written in Italian by Luigi Castiglioni and published in 1790 in Milan, Italy, in two volumes, entitled *Viaggio negli Stati Uniti dell'America Settentrionale fatto negli anni 1785, 1786 e 1787 da Luigi Castiglioni. Con alcune osservazioni sui vegetabili più utile di quel paese.*

Luigi Castiglioni visited the early United States in 1785–1787, traveling through all the 13 states and a portion of Canada. His purpose was, in his own words, twofold. One was to witness the political birth of a republic composed of diverse nationalities extending over a vast area with varied climates and products. Secondly, he desired to investigate the natural productions of the country, particularly those of the vegetable kingdom, studying methods of cultivating and propagating these plants and their uses, with a view of introducing the more useful ones to Europe.

Shortly after his return to Italy Castiglioni published the two volumes of his travels and observations. The book is divided into two parts. The main portion consists of a narrative of his travels in the various states, commenting extensively on their histories and governments, with notes on the manners and customs of the people and on the natural products of the land. The second part, entitled *Osservazioni sui vegetabili più Stati Uniti*, covers from page 169 of the second volume to page 402, the end of the book. This part gives in alphabetical order after the manner of Marshall's *Arbustum*, descriptions and observations on all the common trees and shrubs and some of the more interesting herbs.

Elsewhere I have treated the observations made by Castiglioni on the intriguing relationship between the flora of eastern Asia and that of eastern North America.[1] The present paper deals with the new plant names given in Castiglioni's work.

Castiglioni followed consistently Linnaeus's binomial nomenclature. Aside from Linnaeus, to whom he credited most of the species he described, the other most frequently quoted author is Humphrey Marshall, his *Arbustum Americanum* of 1785. The pre-Linnaean *Flora Virginica*, 1739, of Gronovius is also often quoted. Other authors frequently mentioned include Miller and Lamarck.

As a taxonomic contribution, Castiglioni's work is perhaps not comparable in importance to that of his immediate predecessors Wangenheim and Marshall. However, he consistently adopted a broad concept of species, treating many specific names of other authors as varieties of a single species. Such species of inclusive nature were in most cases not accepted by later authors, but they did indicate relationships between the component varieties, at least as Castiglioni interpreted them.

Most of the new names in Castiglioni's work are of varietal status. Only 14 new species names are noted, indicated by Castiglioni with the letter "N". Some of these are actually the same as Linnaeus or Marshall or other author's earlier names

[1] LI, H. L. *Luigi Castiglioni as a pioneer in plant geography and plant introduction.* Proc. Amer. Philos. Soc. **99:** 51–56, 1955.

but without citation of these authors; some of them were perhaps not intended as new names by Castiglioni although he seems to attach with care author's names to all other species. A few others, however, are genuine new names first proposed by Castiglioni. None of these specific names have been taken up by Index Kewensis.

Castiglioni's work, as noted above, has been much overlooked by most later botanists. In 1891 Faxon published a note[2] calling attention to this interesting work especially because of Castiglioni's early notice of the floristic relationships between eastern Asia and eastern North America. But in subsequent years Castiglioni's work still received little attention from taxonomists as well as writers on early American botany.

So far as I am aware Sargent was the first botanist who took account of any of Castiglioni's taxonomic notes. He quoted Castiglioni, though only occasionally and sporadically in the bibliographical references given in his *Sylva of North America* (1891–1902). He was the first and only one to adopt for use a Castiglioni epithet: *Populus balsaminifera* var. *virginiana* (Cast.) Sargent in Journ. Arnold Arb. **1:** 63. 1919, basing it on *Populus nigra β virginiana* Cast. Actually, Castiglioni is not to be credited with this epithet, as he cited clearly in the synonymy the earlier *Populus virginiana* Fouger. Sargent's name was later changed to *Populus deltoides virginiana* (Cast.) Sudworth, Check List Forest Trees U. S. (U. S. Dept. Agr. Circ. 92): 65. 1927. Rehder adopted this name in his *Manual of cultivated trees and shrubs* in 1940 but later reduced this name into the straight synonymy of *Populus deltoides* Marsh. in his *Bibliography of cultivated trees and shrubs* of 1948.

In Rehder's above-mentioned bibliography, Castiglioni's varietal names received the most complete listing. However, only 20 out of the total 44 new varietal names, and none of the specific names are listed.

Rehder apparently did not give Castiglioni's work a complete examination for its botanical names. His varied versions in abbreviating Castiglioni's work indicate that it had been consulted at random and at separate intervals. In one instance, this work is quoted in parenthesis. In other instances, Castiglioni's work is cited in numerous variable forms as Viaggio Stat. Un. Am. Sept. (sic); Viaggio Stati Un.; Viagg. Stati Uniti; Viagg. Stati Unit.; Viagg. Stat. Uniti; Viagg. St. Uniti; Viag. Stati Uniti.

Most of the varietal names are found in Gray Herbarium Card Index, but at least six such names are noted to be unlisted there and none of the specific names are listed.

The following notes list all the new names appearing in Castiglioni's work following the same alphabetical order given by him. The identifications are made from his descriptions, given in all cases in Latin, his citations of synonymy, common English names, and his notes and observations. In only one instance, *Campsis radicans* var. *minor*, is a Castiglioni name herein adopted to replace a name of current usage. Besides the following, in his text on page 333, Castiglioni mentioned a "*Helianthus spec. nov.*" from Virginia with the common name "S. Andrew's Cross." This is probably *Ascyrum hypericoides* Linn. Again, on page 383, under Spiraea, he mentioned *Hypericum frutex*, a name (*nomen nudum*) which has also not appeared elsewhere. In the following list * marks those names that are not recorded by Rehder (1948), ° those not recorded by Gray Card Index (to date), and † marks specific names not listed in *Index Kewensis*.

*†° *Aesculus pavia* Cast. Viaggio **2:** 187. 1790. = *Ae. pavia* Linn. 1753. Castiglioni does not cite *Ae. pavia* Linn.

*†° *Aesculus lutea* Cast. Viaggio **2:** 187. 1790. = *Ae. octandra* Marshall 1785. Castiglioni does not cite *Ae. lutea* Wangenheim 1788.

* *Betula lenta α rubra* Cast. Viaggio **2:** 207. 1790. = *B. nigra* Linn. 1753.

* *Betula lenta β papyrifera* Cast. Viaggio **2:** 207. 1790. = *B. papyrifera* Marshall 1785. Castiglioni does not cite Marshall's name.

[2] FAXON, C. E. *Castiglioni's travels in the United States.* Garden & Forest **4**(159): 110–111. 1891. I am indebted to Dr. Roland M. Harper for bringing this article to my attention.

* *Betula lenta* γ *populifolia* Cast. Viaggio **2:** 207. 1790. = *B. populifolia* Marshall, 1790. Castiglioni does not cite Marshall's name.

* *Betula lenta* δ *humilis* Cast. Viaggio **2:** 207. 1790. = *B. pumila* Linn., 1767. Gray Card Index considers this as based on *B. humilis* Marshall, but Castiglioni does not list that name.

* *Bignonia radicans* β *minor* Cast. Viaggio **2:** 210. 1790. = *Campsis radicans* var. *speciosa* (Parsons) Voss, 1911. = *Campsis radicans* var. *minor* (Cast.), comb. nov. This is undoubtedly the variety with smaller more reddish flowers. Castiglioni's name should be adopted to replace Parsons 1887 which is a *nomen nudum*. See Rehder (1948, cited above) for complete synonymy.

*† *Cercis canadensis* Cast. Viaggio **2:** 223. 1790. = *C. canadensis* Linn., 1753. Castiglioni gives *Siliquastrum canadense* Tourn. in synonymy. The omission of Linnaeus's name might be just an oversight on the part of Castiglioni as he otherwise cites *C. siliquastrum* Linn. correctly.

* *Fraxinus americana* β *alba* (Marshall) Cast. Viaggio **2:** 244. 1790. = *F. americana* Linn., 1753. Based on *F. alba* Marshall, 1785.

* *Fraxinus americana* γ *pennsylvanica* (Marshall) Cast. Viaggio **2:** 244. 1790. (as *pensylvanica*). = *F. pennsylvanica* Marshall, 1785. Rehder gives *F. americana* var. *pennsylvanica* Wesmael, 1892, in the synonymy.

* *Fraxinus nigra* β *juglandifolia* (Lamarck) Cast. Viaggio **2:** 244. 1790. = *F. americana* var. *juglandifolia* (Lamarck) D. J. Browne, 1846. Based on *F. juglandifolia* Lamarck 1788.

* *Fraxinus nigra* γ *pubescens* (Lamarck) Cast. Viaggio **2:** 244. 1790. = *F. pennsylvanica* Marshall, 1785. Based on *F. pubescens* Lamarck 1788.

* *Fraxinus nigra* δ *sambucifolia* (Lamarck) Cast. Viaggio **2:** 244. 1790. = *F. nigra* Marshall, 1785. Based on *F. sambucifolia* Lamarck 1786. Rehder gives *F. nigra* var. *sambucifolia* D. J. Browne, 1846, in the synonymy.

Gleditschia triacanthos β *aquatica* (Marshall) Cast. Viaggio **2:** 249. 1790. = *Gleditsia aquatica* Marshall, 1785.

Gleditschia triacanthos γ *inermis* Cast. Viaggio **2:** 249. 1790. = *Gleditsia triacanthos* f. *inermis* (Linn.) Zabel, 1903.

Juglans alba ε *pacana* Cast. Viaggio **2:** 262. 1790. = *Carya illinoensis* (Wangenheim) K. Koch, 1869. Apparently based on *J. pecan* Marshall, 1785, but Castiglioni gives a different spelling for the specific epithet.

Lonicera sempervirens α *virginiana* (Marshall) Cast. Viaggio **2:** 284. 1790. = *L. sempervirens* Linn., 1753. Based on *L. virginiana* Marshall, 1785.

Lonicera sempervirens β *caroliniana* (Marshall) Cast. Viaggio **2:** 285. 1790. = *L. sempervirens* f. *minor* (Ait.) Rehder, 1903. Based on *L. caroliniana* Marshall, 1785.

*†° *Mespilus Oxyacantha* (Linn.) Cast. Viaggio **2:** 292. 1790. = *Crataegus Oxyacantha* Linn., 1753. Based on Linnaeus's name.

Mespilus Oxyacantha β *americana* Cast. Viaggio **2:** 292. 1790. = *Crataegus marshallii* Eggleston, 1908.

*†° *Mespilus Azarolus* (Linn.) Cast. Viaggio **2:** 292. 1790. = *Crataegus Azarolus* Linn., 1753. Based on Linnaeus's name.

Mespilus Azarolus β *americana* Cast. Viaggio **2:** 292. 1790. = *Crataegus Azarolus* Linn., 1753.

Mespilus Azarolus δ *aurea* (Marshall) Cast. Viaggio **2:** 292. 1790. = *Crataegus uniflora* Muenchhausen, 1770. Based on *M. Oxyacantha aurea* Marshall, 1785.

*†° *Mespilus coccinea* (Linn.) Cast. Viaggio **2:** 293. 1790. Based on *Crataegus coccinea* Linn., 1753, an ambiguous name now referred to *C. pedicellata* Sargent and *C. intricata* Lange. Rehder lists a different name *M. coccinea* Waldstein & Kitaibel, 1812, in the synonymy of *Crataegus tomentosa* (Ait.) Lindl. *Mespilus coccinea* Marshall, based on the same Linnaean name, is not cited by Castiglioni or by Rehder.

Mespilus coccinea β *viridis* (Linn.) Cast. Viaggio **2:** 293. 1790. = *Crataegus viridis* Linn., 1753.

*†° *Mespilus tomentosa* (Linn.) Cast. Viaggio **2:** 293. 1790. = *Crataegus crus-galli* Linn., 1753. Castiglioni's name is based on *Crataegus tomentosa* Linn., an ambiguous name. He considers it as synonymous to *Mespilus cuneiformis* Marshall. Rehder lists *M. cuneiformis* Marshall twice, under *Crataegus crus-galli* Linn. and *C. punctata* Jacq.

* *Mespilus tomentosa* β *lutea* Cast. Viaggio **2:** 293. 1790. = *Crataegus calpodendron* (Erh.) Medicus, 1793.

Mespilus amelanchier β *nivea* (Marshall)

Cast. Viaggio **2:** 293. 1790. = *Amelanchier arborea* (Mich. f.) Fernald, 1941. Based on *M. nivea* Marshall, 1785.

Mespilus amelanchier γ *prunifolia* (Marshall) Cast. Viaggio **2:** 293. 1790. = *Aronia prunifolia* (Marshall) Rehder, 1938. Based on *M. prunifolia* Marshall, 1785.

* *Mespilus amelanchier* δ *canadensis* (Linn.) Cast. Viaggio **2:** 294. 1790. = *Amelanchier canadensis* (Linn.) Medicus, 1793. Based on *M. canadensis* Linn. 1753.

*†° *Mespilus crus-galli* (Linn.) Cast. Viaggio **2:** 294. 1790. = *Crataegus crus-galli* Linn., 1793. Based on Linnaeus's name. Castiglioni does not cite *M. crus-galli* Marshall, similarly based.

* *Mespilus crus-galli* β *lucida* (Miller) Cast. Viaggio **2:** 294. 1790. = *Crataegus crus-galli* Linn., 1753. Based on *C. lucida* Miller, 1768.

* *Mespilus arbutifolia* β *virginiana* Cast. Viaggio **2:** 294. 1790. Castiglioni's name is derived from *"Crataegus virginiana* Miller Dict. no. 4." This name probably refers to *Mespilus virginiana* Miller ed. 8. 8 m. no. 11. 1768. = *Amelanchier canadensis* (Linn.) Medicus, 1793, and is therefore not referable to *Aronia arbutifolia* (Linn.) Persoon, 1806.

° *Myrica cerifera* α *arborescens* Cast. Viaggio **2:** 302. 1790. = *Myrica cerifera* Linn., 1753.

*° *Myrica cerifera* β *frutescens* Cast. Viaggio **2:** 302. 1790. = *Myrica cerifera* Linn., 1753.

*†° *Nyssa aquatica* Cast. Viaggio **2:** 304. 1790. = *Nyssa aquatica* Linn., 1753. This species is described by Castiglioni without citing Linnaeus as the authority but evidently referring to the same plant now circumscribed as *Nyssa aquatica* Linn., the latter in its original form being a composite name including in part *N. sylvatica* Marshall and *N. ogeche* Bartram. The two latter species are also correctly differentiated and described by Castiglioni and properly credited to the two authors. Sargent in his *Sylva of North America* **5:** 73–84. 1893 disregards Linnaeus's *N. aquatica* and credits all three species to Marshall. Castiglioni, however, attaches only Marshall's name to *N. sylvatica*. Sargent also cites in the same work the references to Castiglioni under *N. sylvatica* and *N. ogeche* but fails to mention him under *N. aquatica*.

Pinus Taeda β *echinata* (Miller) Cast. Viaggio **2:** 312. 1790. = *Pinus echinata* Miller, 1768.

*† *Pinus Taeda* γ *rigida* (Marshall) Cast. Viaggio **2:** 313. 1790. = *Pinus rigida* Miller, 1768. Based on *"P. rigida* Marshall" listed in the synonymy.

* *Pinus Taeda,* δ *palustris* (Miller) Cast. Viaggio **2:** 313. 1790. = *P. palustris* Miller, 1768.

Pinus sylvestris β *norvegica* Cast. Viaggio **2:** 313. 1790. = *P. resinosa* Aiton, 1789.

* *Pinus sylvestris* γ *novo-caesariensis* Cast. Viaggio **2:** 313. 1790. = *P. virginiana* Miller, 1768.

Pinus sylvestris δ *flava* Cast. Viaggio **2:** 314. 1790. = *P. ecinata* Miller, 1768.

*†° *Pinus Balsamea* Cast. Viaggio **2:** 314. 1790. = *Abies balsamea* (Linn.) Miller, 1768. It is conceded that Castiglioni does not intend to name this plant but has failed to record Linnaeus as the authority.

*†° *Pinus americana* (Miller) Cast. Viaggio **2:** 314. 1790. = *Tsuga canadensis* (Linn.) Carriere, 1855. Castiglioni cites *Abies americana* Miller, 1768, and *Pinus Abies americana* Marshall, 1785. Castiglioni's name is a later one than *Pinus americana* DuRoi, 1771, as given by Rehder.

Pinus canadensis α *alba* Cast. Viaggio **2:** 314. 1790. = *Picea glauca* (Moench) Voss, 1908.

Pinus canadensis β *nigra* Cast. Viaggio **2:** 315. 1790. = *Picea mariana* (Miller) Britton, 1888. Gray Card Index considers this as based on *P. nigra* Aiton, 1789, but Castiglioni does not give the latter name.

"Pinus Larix β *rubra,* γ *nigra,* δ *alba* Cast. Viaggio **2:** 315. 1790." Rehder gives these three names as synonyms of *Larix laricina* (DuRoi) K. Koch and credits them to Castiglioni. Actually as clearly noted by Castiglioni, these were named earlier by Marshall.

Populus nigra β *virginiana* (Fouger.) Cast. Viaggio **2:** 334. 1790. = *P. deltoides* Marshall, 1785. This is the only name of Castiglioni that appears in current usage. As Castiglioni cites *P. virginiana* Fougeroux, 1787, this is apparently the origin of this epithet, a fact neglected by later authors like Sargent and Sudworth. Sargent is the first and only one to adopt a Castiglioni name, effecting the combination *Populus balsamifera* var. *virginiana* (Cast.) Sargent in

Journ. Arnold Arb. **1:** 63. 1919. This was subsequently changed to *P. deltoides virginiana* (Cast.) Sudworth, Check List Forest Trees U. S. (U. S. Dept. Agr. Misc. Circ. 92): 65. 1927, apparently without verifying the original work of Castiglioni. This is considered as the typical form of the species in Rehder's Manual (1940) and as a straight synonym of *Populus deltoides* in his Bibliography (1948).

*†° *Populus canadensis* Cast. Viaggio **2:** 334. 1790. = *P. deltoides* Marshall 1785. The description shows that this species is referable to *P. deltoides* Marshall which Castiglioni lists as a synonym with a question mark. Rehder gives *P. canadensis* Michaux f. 1813 in the synonymy of *P. deltoides*, which is apparently the same name earlier established by Castiglioni.

° *Prunus domestica β americana* (Marshall) Cast. Viaggio **2:** 339. 1790. = *P. americana* Marshall 1785.

° *Prunus lusitanica β serratifolia* (Marshall) Cast. Viaggio **2:** 340. 179 = *P. caroliniana* (Miller) Aiton, 1789. Based on *P. Laurocerasus serratifolia* Marshall, 1785.

* *Quercus Prinus β platanoides* Cast. Viaggio **2:** 346. 1790. = *Q. bicolor* Willdenow, 1801.

*° *Quercus nigra β aquatica* Cast. Viaggio **2:** 346. 1790. = *Q. nigra* Linn. 1753. Rehder gives *Q. nigra aquatica* Lamarck, 1785.

*†° *Quercus pumila* Cast. Viaggio **2:** 347. pl. 13. 1790. = *Q. ilicifolia* Wangenheim 1787. In the synonymy Castiglioni gives *Q. pumila* Banister and *Q. rubra nana* ? Marshall. I have not been able to locate Banister's name in other references. It appears that other then the *nomen nudum Quercus pumila* W. Young, *Q. pumila* Cast. is the earliest name bearing this specific epithet. *Quercus ilicifolia* Wangenheim, however, takes precedence.

* *Quercus rubra β hispanica* Cast. Viaggio **2:** 347. 1790. = *Q. palustris* Muenchhausen, 1770.

*° *Vaccinium corymbosum β myrsinites* (Lamarck) Cast. Viaggio **2:** 391. 1790. = *V. myrsinites* Lamarck, 1783.

*†° *Vaccinium laevigatum* Cast. Viaggio **2:** 391. 1790. This species is described by Castiglioni as follows:

> "2. V. LAEVIGATUM, *floribus corymbosis, bracteis, corymbis alternis; foliis lanceolato-oblongis, acuminatis, subserratis, utrinque glabris*, N.
> "*Obs.* Frutex orgyalis. Differt a V. corymboso, Linn. foliis subtus majis venosis, utrinque glabris, a V. ligustrino. Linn. floribus corymbosis bracteatis; foliis amplioribus magis venosis.
> "High-blue-berry nel *Massachusset*".

This plant appears to be referable to *Vaccinium corymbosum* f. *glabrum* (Gray) Camp. However, in this highly complex genus, it will be more desirable to leave the disposition to the experts. Incidentally this specific name is not recorded in Index Kewensis and it actually invalidates *V. laevigatum* Boj. ex Dunal in DC. Prodr. 7: 571. 1838, of Madagascar.

*° *Vaccinium oxycoccus β hispidulum* Cast. Viaggio **2:** 392. 1790. = *V. macrocarpum* Aiton, 1789. Castiglioni cites "*Vaccinium hispidulum* ? Lin." in synonymy, which is *Chiogenes hispidula* (Linn.) Torrey & Gray, 1843.

* *Xanthoxylum clava-herculis β americanum* Cast. Viaggio **2:** 399. 1790. = *Zanthoxylum americanum* Miller, 1768. Castiglioni does not cite Miller's species. His varietal name is also antedated by *Z. clava-herculis* var. *americanum* (Miller) C. F. Ludwig, 1783, as given by Rehder.

ACADEMY MEMBERS IN THE NEWS

HARRY WEXLER, chief of the science services division of the U. S. Weather Bureau, has been given the highest civilian award of the U. S. Air Force, the Exceptional Service medal.

JAMES M. HUNDLEY, former chief of the Laboratory of Nutrition and Endocrinology, NIAMD, is on a 2-year leave of absence, to administer a research program for the United Nations Childrens Emergency Fund and the Food and Agriculture Organization of the United Nations.

JAMES A. SHANNON, director of the National Institutes of Health, is the senior author of a recent paper in Science, *Medical Research in Perspective*.

BOTANY.—*New species of* Erythroxylon *from Colombia.* WALTER A. GENTNER.[1] (Communicated by Lyman B. Smith.)

Four new species were determined while preparing a field guide to the genus *Erythroxylon* in Colombia. The guide in its entirety was submitted to the faculty of the Columbian College of the George Washington University in partial satisfaction of the requirements for the degree of master of arts. Plans for the publication of this guide have been delayed, and it seems well to record the new species here.

Measurements in the descriptions are all from dry material to keep the relative proportions of all parts. In the illustrations the details are from boiled material, but they are not appreciably larger except in the case of the stipules.

Erythroxylon cuatrecasasii Gentner, sp. nov.

Arbor 8 m alta; cortice obscure purpureo-brunneo, verruculoso, lenticellis dilute rubris; petiolo 3–6.5 mm longo, foliis lanceolatis, basi acutis, apice acuminatis, 79–148 mm longis, 21–44 mm latis, bilineatis; stipulis non persistentibus, 1.5–2 mm longis, triangulatis, asetulosis; floribus uno vel plurimis in axillis foliorum vel ramentorum; pedicellis 4–9 mm longis, ad apicem versus incrassatis, 5-angulatis; calyce ad ¾ partito, laminis 1–2 mm longis, late lanceolatis. Floribus brachystylis: calyce superante urceolum stamineum, orificio subintegro, staminibus 1.5 mm longis, stylis liberis, 1 mm longis, stigmatibus depresso-capitatis. Floribus dolichostylis: non visis. Drupa 8.5–10.5 mm longa, 3.5–4 mm diametro.

VALLE DEL CAUCA: Río Yurumangui, alt. 5–50 m, February 19, 1944. J. Cuatrecasas 15736.

This species differs from *E. gracilipes* and *E. acutum* in having lanceolate leaves.

Erythroxylon acutum Gentner, sp. nov.

Frutex vel arbor 3–4 m alta; cortice obscure purpureo-brunneo, verruculoso, lenticellis minutis dilute rubris; petiolo 3–7 mm longo, foliis oblongo-ellipticis, basi rotundatis, apice acuminatis, 30–81 mm longis, 14–32 mm latis, bilineatis; stipulis persistentibus, 1–1.5 mm longis, fimbratis, triangulatis, 3-setulosis; floribus uno vel plurimis in axillis foliorum vel ramentorum; pedicellis 4–6 mm longis, ad apicem versus incrassatis, 5-angulatis; calyce ad ½ partito, laciniis 1–1.5 mm longis, triangulatis, acutis; floribus dolichostylis non visis. Floribus brachystylis: urceolo staminео calycem subaequante, orificio subintegro; staminibus 2.5–3 mm longis; stylis liberis, 2 mm longis; stigmatibus depresso-capitatis; floribus brachystylis e fragmentis solum cognitis. Drupa 7.5–9 mm longa, 2.5–3 mm diametro.

NARIÑO: Gorgonilla Island, alt. 130–200 m, February 28, 1939, E.P. Killip and H. García-Barriga 33082.

This species differs from *E. cuatrecasasii* in having oblong-elliptic leaves.

Erythroxylon acrobeles Gentner, sp. nov.

Frutex parvus, cortice griseo-brunneo, verruculoso; petiolo 3–5 mm longo, foliis obovatis vel ellipticis, basi acutis vel rotundatis, apice acutis, cuspidatis, mucronatis, 72–173 mm longis, 26–60 mm latis; stipulis 3.5–5 mm longis triangulatis, apice acutis, 2-setulosis; floribus uno vel plurimis in axillis foliorum vel ramentorum; pedicellis 4–9 mm longis, ad apicem versus incrassatis, 5-angulatis; calyce ad ½ partito, laminis 1–1.5 mm longis, ovatis, mucronatis. Floribus brachystylis: non visis. Floribus dolichostylis: staminibus inaequalibus, episepalis 0.4 mm longis, epipetalis 1.5–1.75 mm longis, urceolo stamineo calycem superante, orificio subintegro, stylis liberis, 0.75 mm longis, stigmatibus depresso-capitatis, ovario obovoideo. Drupa 13 mm longa, 7 mm diametro.

VALLE DEL CAUCA: Pacific coast at Río Cajambre, May 5–15, 1944, J. Cuatrecasas 17581.

This species differs from *E. cumanense* and *E. havanense* in having cuspidate leaves 72–173 mm long.

Erythroxylon haughtii Gentner, sp. nov.

Frutex ultra 2 m alta; cortice griseo-brunneo, verruculoso, lenticellis dilute rubris, ramulis recurvatis, compressis; petiolo 3–6 mm longo, foliis ovatis vel ellipticis, basi apiceque rotundatis, 22–57 mm longis, 23–32 mm latis; stipulis persistentibus, 1.5–2 mm longis, fimbriatis, triangulatis, 3-setulosis; floribus 1–4 in axillis foliorum vel ramentorum; pedicellis 7–11 mm longis, graciliter obconicis, 5-angulatis; calyce ad ¾

[1] Field Crops Research Branch, ARS, USDA, Beltsville, Md.

FIG. 1.—*Erythroxylon cuatrecasasii*: A, Habit, × ½; B, calyx, × 5; C, stamens, × 5; D, stipule, × 5.

FIG. 2.—*Erythroxylon acutum*: A, Habit, × 1; B, calyx, × 5; C, stamens, × 5; D, stipule, × 5.

FIG. 4.—*Erythroxylon haughtii*: A, Habit, × 1; B, calyx, × 5; C, stamens and ovary, × 5; D, ovary, × 5; E, stipule, × 5.

FIG. 3.—*Erythroxylon acrobeles*: A, Habit, × ½; B, calyx, × 5; C, stamens and ovary, × 5; D, ovary, × 5; E, stipule, × 5.

partito, laciniis 1.5–2 mm longis, late lanceolatis; petalis 2.5–3 mm longis, laminis 2.5–3 mm longis, ligula laminam ad ¾ aequante. Floribus brachystylis: urceolo stamineo calycem subaequante, orificio 10-crenulato; staminibus 2.5 mm longis, stylis liberis, 1 mm longis, stigmatibus depresso-capitatis, ovario ovoideo. Floribus dolichostylis: non visis. Drupa non visi.

CAUCA: Near Mercaderes, alt. 1100 m, October 27, 1946, Oscar Haught 5143.

This species differs from *E. orinocense* and *E. hondense* in having pedicels 7–11 mm long.

PROTECTIVE COATINGS FOR TITANIUM

The National Bureau of Standards has successfully electrodeposited hard, adherent protective coatings on titanium. The procedure involves forming a titanium fluoride film on the metal surface, electroplating with chromium, and heat-treating the plated specimen at 800°C. Developed for the Springfield Armory by C. L. Stanley and A. Brenner of the Bureau staff, the process is expected to extend considerably the utility of titanium metal, particularly for high-temperature applications.

Because of titanium's high strength-to-weight ratio, it ranks with steel and aluminum as a structural material. However titanium has disadvantages for some applications: it tends to gall or seize when in loaded contact with itself or other metals, and it oxidizes at elevated temperatures. These disadvantages could be minimized if titanium were coated with hard, oxidation-resistant metals such as chromium or nickel, but previous attempts to produce such coatings have not been entirely successful. Although the Bureau had obtained good adhesion of aluminum to titanium in an earlier investigation using a nonaqueous plating bath, the method was not suitable for job-shop applications and the results were not sufficiently consistent.

The main problem in depositing metals on titanium is lack of adhesion—some deposits have actually exfoliated during the plating operation and others have been easily pulled off with the fingers. Poor adhesion has been blamed on an oxide film on the base metal, but attempts to remove the suspected film with acid etches or anodic films were not successful. For this reason, the present investigation included a study of the influence of oxide films and methods to remove them.

In a preliminary investigation, the Bureau designed an experiment intended to remove any oxide film and to plate the titanium specimen before it could reoxidize. In this procedure, a small piece of titanium was enclosed in an evacuated tube containing silicon carbide and ceramic balls. The tube was tumbled for several hours to abrade the metal surface and then placed in a chromium plating bath, where it was crushed so as to expose the metal specimen to the bath before the atmosphere could touch it. In a control experiment, a titanium specimen was similarly abraded in an open tube. The adhesion of the first specimen was distinctly better than that of the control, supporting the hypothesis that a film, probably an oxide, exists on the surface of titanium and impairs adhesion of metal deposits.

The Bureau investigated a number of etching and plating procedures and obtained the best chromium plates by pretreating titanium to form a coating of titanium fluoride before plating the specimen. This procedure appears to prevent the formation of an oxide and, when the specimen is placed in the plating bath, the titanium fluoride dissolves permitting the chromium to bond directly to the basis metal.

Titanium specimens are thoroughly degreased and cleaned before this treatment. Next they are dried and suspended in a solution of hydrofluoric and acetic acids. After 10 or 15 minutes a 60-cycle alternating current is passed through the specimen for another 10 minutes. The specimens are then rinsed and transferred to a conventional chromium plating bath, where they are plated at a temperature of 85°C and a current density of 120 amp/dm^2.

Chemical analysis indicates that the film produced by the preliminary acid treatment contains a low valence titanium compound. A sample of the dried film contained 37 percent of titanium and 54 percent of fluorine,

and examination by X-ray diffraction showed no lines characteristic of titanium tetrafluoride.

Tensile strength tests indicate that adherence of the chromium coating to titanium is greatly improved by heat-treating the plated specimen for two minutes at 800°C in an inert atmosphere. Coating adhesion was determined by the nodule method. Essentially this procedure consists in electrodepositing a cobalt nodule, 1/16 in. in diameter, on the coating and then determining the force necessary to detach the nodule together with the coating from the basis metal. The bond strength of the heat-treated specimens ranged from 4,000 to 18,000 lbs/in. Although the highest value obtained is somewhat below the tensile strength of heat-treated chromium, fracture occurred in all cases in the chromium plate and not between the two metals.

Coatings on titanium consisting of 0.02 mm of chromium plus 0.15 mm of nickel were found to be moderately adherent without heat treatment, but not comparable to that of chromium on steel. If such specimens 0.5 inch wide are broken by repeated bending, the chromium-nickel coatings can be stripped from the titanium with a force of about 10 pounds.

Procedures for depositing nickel and copper on titanium have been formulated that are similar to the process for depositing chromium. However, the nickel and copper deposits have not adhered as well as chromium and have frequently blistered.

AWARDS FOR SCIENTIFIC ACHIEVEMENT

As part of its program of encouraging science in the Washington area, the ACADEMY makes annual awards of recognition for achievement. At the 1957 annual meeting, on January 17, President Gibson presented certificates to the following:

In the biological sciences:

EARL REESE STADTMAN
National Heart Institute
National Institutes of Health

FOR THE DISCOVERY OF THE ENZYME TRANSCETYLASE AND THE DISTINGUISHED STUDY OF ITS INTRICATE PART IN FATTY ACID METABOLISM.

In the engineering sciences:

M. L. GREENOUGH
National Bureau of Standards

FOR DISTINGUISHED SERVICE IN THE DEVELOPMENT OF UNIQUE METHODS FOR AUTOMATIC DATA PROCESSING.

Physical sciences:

ELIAS BURSTEIN
Naval Research Laboratory

FOR DISTINGUISHED STUDY OF IMPURITY LEVELS AND EFFECTIVE ELECTRON MASSES IN SEMI-CONDUCTORS.

Teaching of sciences:

PHOEBE HALL KNIPLING
Arlington County Public Schools

FOR DISTINCTION BOTH IN FOSTERING AND IN THE PERSUASIVE TEACHING OF SCIENCE IN SECONDARY SCHOOLS.

PHYSIOLOGY.—*Studies on the oxygen consumption of* Australorbis glabratus *eggs.*

ALINA PERLOWAGORA-SZUMLEWICZ[1] and THEODOR VON BRAND.[2]

(Received November 29, 1956)

The possibility has been pointed out that studies on the physiology of the intermediate hosts of schistosomiasis may yield clues to the development of chemical control measures, (von Brand, Nolan, and Mann, 1948). This reasoning led to extensive studies on snails by several investigators (Mehlman and von Brand, 1951; von Brand and Mehlman, 1953; von Brand, McMahon, and Nolan, 1955; Newton and von Brand, 1955; von Brand, 1955). They investigated the anaerobic and postanaerobic metabolism, the relation between the pre- and postanaerobic oxygen consumption and the oxygen tension, the effect of temperature and tissue hydration on anaerobic survival, and physiological differences between geographical strains. Such studies led to investigations of metabolic pathways potentially vulnerable to chemical attack. Weinbach (1952, 1953) studied the intermediate metabolism of *Australorbis glabratus*, and subsequently the mechanism by which pentachlorophenol kills snails was elucidated (Weinbach, 1954, 1956, Weinbach and Nolan, 1956).

In marked contrast to these studies on adult snails is the complete lack of knowledge concerning the metabolism of snail eggs and the mode of action of chemicals on them. Studies on eggs of other animals suggested that certain compounds such as di and trihalophenols block cleavage of fertilized *Arbacia* eggs (Clowes et al., 1950). It seems then possible that chemical control of the developing eggs of disease-transmitting snails may help in the control of certain parasitic diseases. To lay a foundation towards such an approach, a study of the respiration of *Australorbis glabratus* eggs was undertaken and is reported below.

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[2] Laboratory of Tropical Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health.

MATERIAL AND METHODS

The eggs were obtained from *Australorbis glabratus*, laboratory reared from Venezuelan stock. Twenty-five to thirty adult specimens were kept at room temperature (approx. 25°C) in jars containing 3 to 4 liter dechlorinated tapwater which was renewed once a week. The snails were fed abundantly with lettuce leaves and calcium carbonate was added to the water occasionally. Eight such jars were lined with glass slides on which the snails deposited the egg capsules. Egg clutches were collected daily at 9 a.m. thus permitting a rigorous control of their age. They were carefully removed from the slides with the help of a razor blade and placed in open dishes containing 200 to 300 ml water. Most of the eggs maintained in this way appeared to develop normally and only 5 to 10 percent died before hatching time. Dead eggs could, after some experience, be recognized even macroscopically, at least in the later stages of development. They usually became moldy and heavily contaminated with bacteria and were of course discarded. A further check, especially important with the young stages (zero and one day), was provided by examining the egg capsules under an entomological microscope.

The rate of oxygen consumption of the eggs was studied by means of Warburg manometers equipped with flasks of approximately 6 ml capacity containing 1 ml of dechlorinated tap water as respiratory medium. The carbon dioxide was absorbed in the customary manner by means of 10 percent KOH. An equilibration period of 30 minutes was allowed, and readings were taken at 30 minute intervals for 2 to 3 hours. The manometers were shaken with an amplitude of 4 cm 100 times per minute. The temperature in all experiments was 28°C. The data were calculated per egg. In order to minimize errors, the eggs contained in each egg capsule used in a given experiment were counted both before being introduced into the Warburg flask and at the end of the experiment.

Because the respiratory rate was higher in older eggs than in young ones, the number of clutches, that is of eggs, had to be varied. In most experiments with 0 to 2 day-old eggs, 30 egg capsules were used per flask, while 10 to 15 clutches containing older embryos sufficed to give adequate manometer changes. When it was desired to follow a certain group of clutches during its entire development, the 30 egg clutches used per flask during the first days were divided into smaller lots during the later days, and all these lots were tested on the same days separately, when possible. The egg clutches were introduced into the flasks individually by means of a very fine spatula and at the end of the experiment, they were washed out by means of a little water. Although these manipulations were done with great care, an occasional injury to an egg clutch could not always be avoided. Any damaged clutch was rejected.

RESULTS AND DISCUSSION

Data on the embryology of various species of fresh water snails are available in the literature (*Lymnaea* spp., Lankester, 1874, Crabb, 1927; *Stagnicola*, Lowrance, 1934; various Planorbidae, Holmes, 1900, Roney 1943, Baker, 1945), but no information concerning *Australorbis glabratus* specifically has come to our attention. We therefore record here briefly some pertinent observations.

The number of eggs per egg capsule is quite variable. It varied in the 855 clutches used in the present study from 5 to 58. But it should be pointed out that clutches containing only 2 to 3 eggs are frequently deposited by very young snails, while old specimens occasionally lay capsules containing over 60 eggs. The individual eggs are enclosed by an inner capsule. In it, the ovum proper usually occupies an eccentric position, although it can also be located centrally. Inner capsules containing two ovas or none, occur occasionally. The inner capsule, are arranged in a matrix in irregular, or sometimes parallel rows (Fig. 1 (1, 2)) and are bounded by a thin membrane.

Embryos allowed to develop at room temperature of about 25°C started hatching on the 6th to 8th day after oviposition. Increasing the temperature slightly increased the number of young snails hatching on the 6th day. Decreasing the temperature by 3 to 5°C retarded the development; the first hatchings occurred as late as the 9th or 10th day. There was some variation in the hatching time even among snails of a single egg clutch; the first ones could, for example, hatch on the 6th day with the remainder following during the next 2 to 3 days.

A detailed study of the embryology of *Australorbis* was not done. However, we did make sufficient observations to indicate that this snail follows the usual planorbid pattern. Representative stages are shown in Fig. 1 (3 to 9). They show the main stages used during our determinations of the oxygen consumption on the following days: 0, 1, 2, 4, 5, and 6, and, since taken at the same magnification, can serve as indication of the increase in living substance. The stage reached on day 3, although tested for oxygen consumption, was not photographed; it corresponded approximately to pre-veliger stage. Of some interest in connection with our respiratory studies is the motility of the embryos. First rotation of the developing ova occurred on day 2. On day 4 the embryos were already very active, moving actively around within the inner capsule; at this stage the heart beat was clearly visible. During the last day of development some variation in motility was noticed. Some of the now fully developed young snails were very active and were escaping the egg clutch. Others were more quiescent, and these required one or two days more to leave the clutch.

Two independent sets of experiments were conducted in which the rate of oxygen con-

FIG. 1.—Representative stages in the development of the eggs of *Australorbis glabratus*: (*1*) Complete egg clutch, 0 day, showing the arrangement of the inner capsules within the clutch, 10 ×. (*2*) Complete egg clutch, 6th day, showing the growth of the embryo, 10 ×. (*3*) Single egg, 0 day, cleavage stage, 90 ×. (*4*) Single egg, 1st day, probably trochophore stage, 90 ×. (*5*) Single egg, 2 days, post-trochophore stage, 90 ×. (*6*) Single egg, 3 days, veliger stage, 90 ×. (*7*) Single egg, 5 days, well developed embryo within the shell, 90 ×. (*8*) Freshly hatched snail in water, 90 ×. (*9*) Freshly hatched snail in air, retracted into the shell. 90 ×.

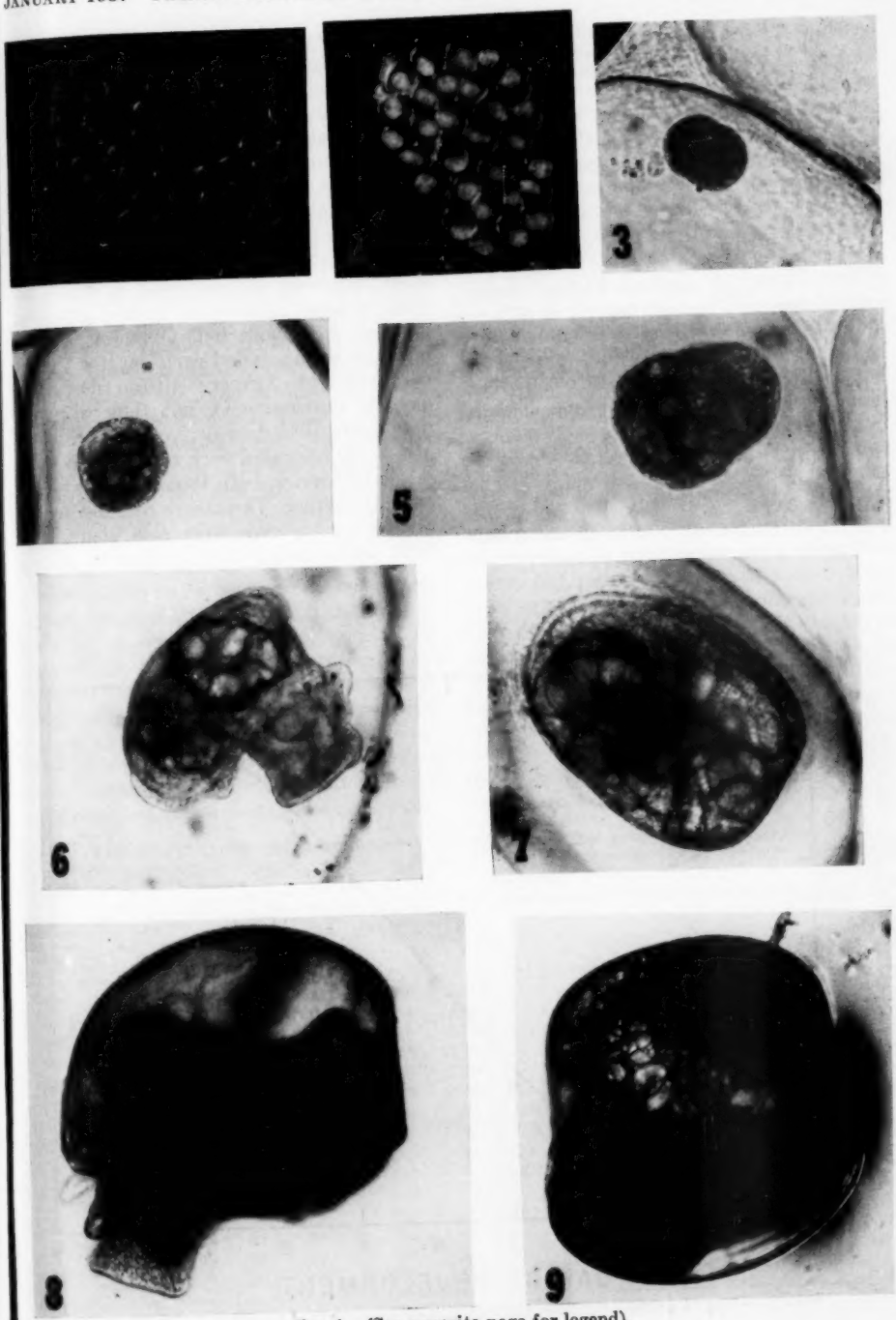

FIG. 1.—(See opposite page for legend).

TABLE 1.—OXYGEN CONSUMPTION OF *AUSTRALORBIS GLABRATUS* EGGS FROM TIME OF DEPOSITION TO HATCHING

Number of experiments	Number of egg-capsules	Number of eggs in a single experiment	Age in days	Mm^3 oxygen consumed by one egg in one hour
8	224	811 (367, 992)	0	0.005 (0.004, 0.006)
7	203	774 (589, 866)	1	0.007 (0.006, 0.009)
8	206	703 (494, 992)	2	0.014 (0.011, 0.018)
10	238	582 (367, 872)	3	0.017 (0.014, 0.024)
8	189	554 (315, 877)	4	0.031 (0.028, 0.034)
14	285	467 (280, 752)	5	0.044 (0.035, 0.059)
13	245	438 (254, 752)	6	0.057 (0.048, 0.068)
11	215	464 (266, 752)	7	0.061 (0.049, 0.074)
11	146	357 (283, 504)	8	0.066 (0.054, 0.088)

sumption was determined. In the first series, the same egg clutches were used from 5 to 6 times on alternate or successive days. In view of the rapid development of the ova, care was taken to control the time intervals rigidly, that is, all the experiments started at 9 a.m. Because initially some doubts existed whether the repeated handling of the egg clutches and the shaking in the Warburg flasks might interfere with normal development, a second set was done in which initially a large number of freshly deposited clutches were collected. Of these, certain numbers were selected each day for the experiments (2 to 7 experiments on the various days of development), but they were not used again. The data derived from this second series coincided very closely with those of the first series, both therefore, can be discussed together. The stages reached by the developing embryos were also identical in both series; it is hence justified to assume

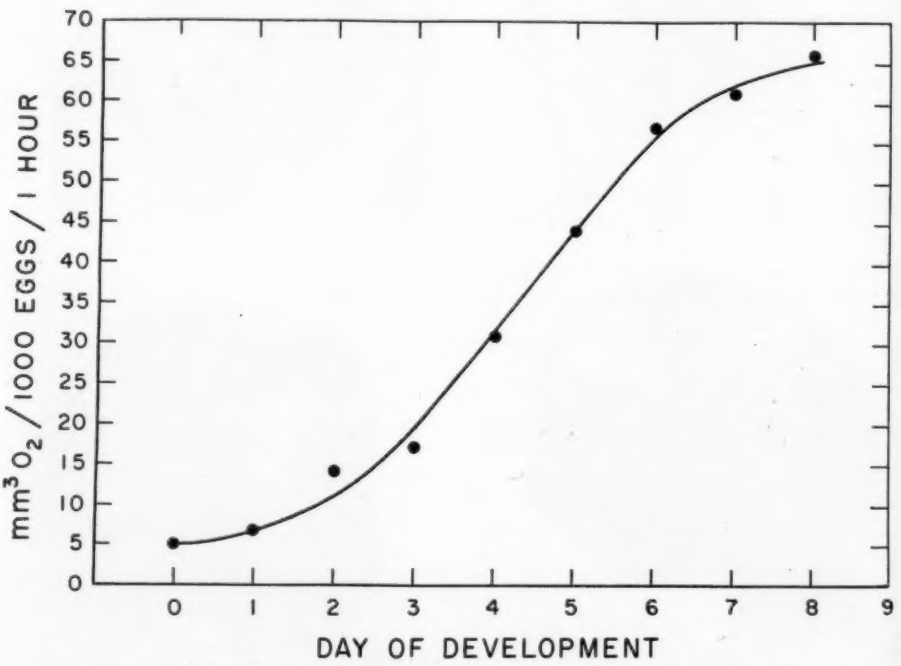

FIG. 2.—Rate of oxygen consumption of developing eggs of *Australorbis glabratus*

that we were dealing with "normal" clutches. This point was further checked by comparing the developmental stages of our experimental clutches with clutches that were not handled at all; we were unable to observe any differences.

Table 1 and Fig. 2 summarize the average results, while Table 2 gives details of the first series. It is evident that the variability in oxygen consumption was relatively small. This is true especially for the very young stages, but even in the older ones uniform results were obtained. This, undoubtedly, was due to the large number of embryos used per Warburg flask. The average values arrange themselves to a smooth curve (Fig. 2) which has an S-shaped form. This is exactly the same type of curve as found during the development of the embryos of higher animals, e.g., hen's egg (Bohr and Hasselbalch, 1900, 1903; Murray, 1925) or turtle egg, (Lynn and von Brand, 1945).

This finding has a bearing on another important point. In working with the type of material as ours, a perennial question is whether the results obtained are really exclusively due to the material one wishes to study, or whether bacterial contaminants obscure the picture. Our egg clutches were certainly not bacteriologically sterile and we cannot exclude categorically slight bacterial contamination. Gross contamination is easily recognized and occurs only when dying eggs are present; as mentioned previously, such clutches were always discarded immediately. It does not seem likely that a smooth curve as shown in Fig. 2 would have been obtained if bacterial respiration had been superimposed to a marked degree on the respiration of the developing snails. Furthermore, in experiments unrelated to the present ones, we tested the respiratory rate of 4 groups of freshly hatched snails, each group comprising 100 to 150 specimens. The egg clutches from which these snails were derived consumed per embryo, just before hatching, 0.064, 0.075, 0.087, and 0.088 mm^3 O_2 per hour. The corresponding values after hatching were 0.086, 0.116, 0.117, and 0.117 mm^3 per young snail per hour. The average value for the embryos was 0.078 mm^3 and for the newly hatched snail 0.109 $mm.^3$ Bacteria would of course not have developed to a marked degree within the developing embryos, but rather in the matrix. If a large number would have been present, one would have expected the respiration of the embryos to have been higher than that of the young snail, while the opposite was true. That the freshly hatched snail should consume somewhat more oxygen than the fully developed embryo is not surprising; the greater activity of the former alone is probably sufficient to explain the difference. We are therefore

TABLE 2.—OXYGEN CONSUMPTION OF DEVELOPING EGGS OF *AUSTRALORBIS GLABRATUS*

Number of egg-capsules in each test from 0–4th day	Number of eggs in each test 0–4th day	Extreme number of eggs in each capsule		Number of egg-capsules in each test from 5th–8th day	Number of eggs in each test 5th–8th day	mm^3 Oxygen consumed by one developing egg in one hour on day								
		min.	max.			0	1	2	3	4	5	5	7	8
30	872	16	42	16	395	0.005	—	—	0.018	—	0.039	—	0.061	0.064
30	851	15	45	20	504	0.005	—	0.016	—	—	0.040	0.055	0.058	0.088*
32	992	14	43	20	410	0.005	—	0.018	—	—	0.041	0.056	0.064	0.073*
30	877	16	30	20	395	0.006	—	—	—	0.031	0.059	0.068	—	0.087*
30	670	12	41	18	350	0.004	—	—	0.017	0.033	—	0.049	0.059	—
18	367	13	40	18	367	0.005	—	—	0.018	—	—	—	—	—
24	589	5	42	18	423	—	0.008	0.014	—	—	0.047	0.057	0.060†	—
30	790	10	45	30	727	—	0.008	0.014	0.024	—	—	—	0.062	—
30	854	12	42	29	752	—	0.006	0.013	—	—	0.043	0.050	0.074†	—
29	689	14	38	28	624	—	0.006	—	—	0.030	0.040	—	0.066†	—
30	680	9	44	30	661	—	—	—	0.020	0.034	0.055	0.065	—	—
20	410	7	34	20	381	—	—	—	0.014	—	0.040	0.058	—	—
20	512	6	43	20	493	—	—	—	0.016	—	0.044	0.061	—	—
20	528	11	45	20	497	—	—	—	0.017	—	0.049	0.062	—	—
20	397	7	30	16	358	—	—	—	—	—	0.042	—	0.067	—

* Many hatched snails attached to the surface of outer capsule.
† After test hatched embryos present in the Warburg flask.

confident that our data truly reflect the respiratory activity of the developing snail.

SUMMARY

The rate of oxygen consumption of the developing egg of *Australorbis glabratus* increases from the time of oviposition to hatching, following a curve strikingly similar to that found in egg-laying vertebrates.

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Vague similarities in certain properties are never sufficient to determine a person who earnestly seeks for the truth and is not shackled by hypotheses.—J. BERGMAN.

BIOCHEMISTRY.—*The effect of cortisone on the formation of glycogen from 2-C-14 labeled alanine and lactic acid.*[1] W. C. HESS and I. P. SHAFFRAN, Georgetown University School of Medicine.

(Received November 26, 1956)

The mechanism whereby cortisone stimulates the production of liver glycogen is unknown. Ever since the classical study of Long, Katzin, and Dry (*1*) it has been generally accepted that tissue protein is the source of the carbons in the glycogen. Using the glyconeogenic amino acids glycine and alanine, Hess and Shaffran (*2*, *3*) showed that cortisone did not increase the production of liver glycogen from glycine but did produce a slight increase from alanine. When 2-C-14 labeled DL-alanine and glycine were fed the amount of labeled carbon incorporated at the time of maximum liver glycogen formation was found to be the same whether or not cortisone acetate was injected into the animal (*4*).

It is possible that cortisone acetate may act by influencing the rate of release or incorporation of amino acids in tissue protein and consequently affect liver glycogen production. The previous experiments (*4*) gave no information on rate of incorporation of the labeled carbon in either liver or muscle glycogen and protein. In the present series of experiments cortisone acetate and either 2-C-14 labeled DL-alanine or DL-lactic acid were given to fasting normal rats at the same time. Determination of liver and muscle glycogen and protein nitrogen were made at intervals up to 72 hours. The radioactivity of the liver and muscle glycogen and protein were measured, and also that of the respired carbon dioxide and in the urine.

EXPERIMENTAL

The same procedures for the administration of the DL-alanine and DL-lactic acid and the determination of glycogen were employed as previously described (*3*, *4*). Rats, weighing 100 to 150 g, were fasted for 24 hours and then given either 500 mg of 2-C-14 DL-alanine or DL-lactic acid. When cortisone acetate was given 5 mg were injected intramuscularly at the same time that the compound was fed by stomach tube. The radioactivity of the compounds fed varied from 1.0 to 1.5 $\times$ 10^6 counts per minute, carrier DL-alanine and carrier DL-lactic acid were used to dilute the activity of the radioactive compounds, the 2-C-14 lactic acid was purchased and used as the zinc salt. The proteins from a weighed aliquot of liver and muscle were isolated by the procedure of Levine and Tarver (*5*) and the nitrogen content determined. The radioactivity of the isolated liver and muscle glycogen and protein was determined using an open window gas flow counter. In one series of experiments the rats were placed in a glass metabolism cage and the activity of the respired carbon dioxide and in the urine was counted.

RESULTS

Table 1 contains the data on the glycogen content of the liver in all the experiments and also the amount of the labeled carbon that was incorporated. For each series of experiments the average values are given, at least six rats were used in each experiment. The specific activity of the liver glycogen, calculated as percent of the administered dose per 100 mg of glycogen, is charted for each of the experimental series in Fig. 1.

The data on the relationships between liver weight and body weight are given in Table 2, the results on the determinations of the liver protein nitrogen and the percent incorporation of the 2-C-14 activity in the liver protein are also included. In order to provide a uniform basis for comparison the values are expressed per 100 g of body weight.

The initial weights and also the weights at the end of 72 hours of the rats on the several experimental regimens are given in Table 3. The urine nitrogen values are also included in this table and are expressed as mg. of nitrogen excreted during the 72 hours period per 100 g of body weight. Table 4 gives the data on the glycogen content of the muscle and the nitrogen content of the isolated muscle protein.

The radioactivity of the respired CO_2

[1] These experiments were supported, in part, by a contract with the Atomic Energy Commission.

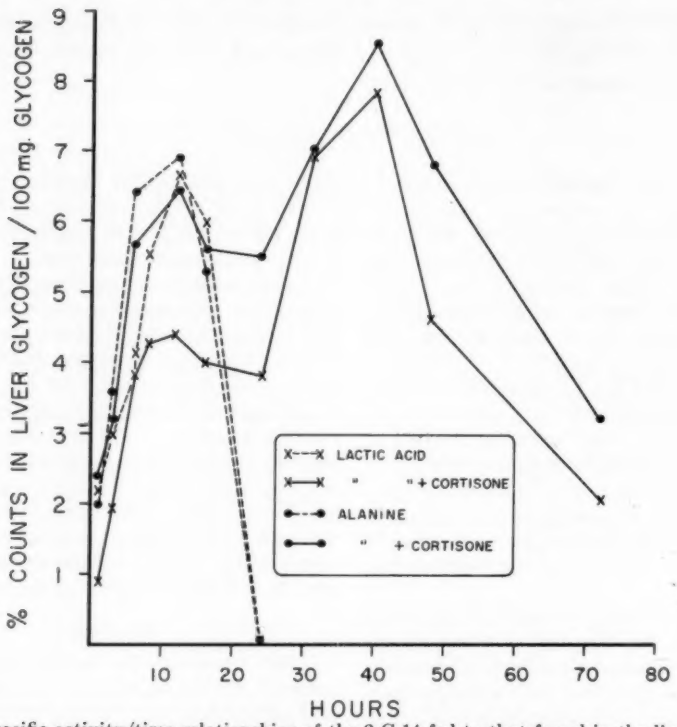

FIG. 1.—Specific activity/time relationships of the 2-C-14 fed to that found in the liver glycogen

after 2, 4, 6, 8, and 24 hours from 2-C-14 DL-alanine was 2.1, 5.6, 30.4, and 62.8 percent respectively of the administered dose. When DL-alanine and cortisone acetate were given the values for the same periods were 1.8, 5.3, 28.3, 32.8, and 63.8 percent, respectively. The activity in the urine for the 24 hour DL-alanine periods was 15.2 percent of the administered dose and for the DL-alanine plus cortisone periods 14.5 percent.

TABLE 1.—LIVER GLYCOGEN CONTENT AND C-14 INCORPORATION

Time (hours)	Alanine		Alanine + Cortisone		Lactic acid		Lactic acid + Cortisone		Cortisone Gly. %
	C-14 Inc. %	Glyc. %	C-14 Inc. %	Gly. %	C-14 Inc. %	Gly. %	C-14 Inc. %	Gly. %	
1	0.5	0.3	0.3	0.5	0.6	0.7	0.4	0.9	0.4
3	1.3	0.9	1.5	1.8	2.6	2.2	2.0	2.5	0.7
6	8.9	3.5	10.3	4.5	6.1	4.0	8.4	5.1	1.6
8	6.5	2.5	7.8	3.2	6.9	3.2	6.7	4.0	1.7
12	6.1	2.2	8.1	2.8	6.7	1.9	5.1	3.4	1.7
16	1.1	0.5	7.1	3.4	3.8	1.7	4.8	3.0	2.4
24	0.2	0.1	7.9	3.6	0.2	0.1	3.8	2.5	2.5
31			9.8	4.1			10.2	4.3	3.8
40			12.9	4.3			16.1	4.8	4.0
48			10.7	4.6			7.4	4.0	3.8
72			6.0	4.3			2.9	3.4	3.3

DISCUSSION

The 2-C-14 of the DL-alanine and DL-lactic acid was rapidly incorporated into the liver glycogen, 9 and 7 percent, respectively, of the administered doses were found at the end of 6 hours, the peak period for glycogen production. Disappearance of the glycogen and the labeled carbon was likewise rapid, at the end of 16 hours 1.1 and 3.8 percent remained from the alanine and the lactic acid respectively. When 5 mg of cortisone acetate was given at the same time either DL-alanine or DL-lactic acid was given the fate of the labeled carbon was quite different. The initial incorporation was just as rapid and approximately to the same extent as when cortisone was not given but subsequently the labeled carbon remained in the glycogen. There was a slight dip both in the actual percent incorporated and in the specific activity between the eighth and the twenty-fourth hours, and then there was a

marked increase both in the amount incorporated and in the specific activity. The increase in specific activity must mean that some of the labeled carbon has been held elsewhere in the animal body and was then released and incorporated into the glycogen.

There was no change in the rate of oxidation of the DL-alanine as reflected by the rate of appearance of the labeled carbon in the respired CO_2 with or without the administration of the cortisone acetate. The rate of elimination was approximately the same as that found for glycine and serine (*6, 5*). Boutwell and Chiang have reported a slight decrease in the rate of CO_2 formation from C-14 labeled glucose following cortisone acetate administration (*7*). However, Welt et al. were unable to find any difference in the rate of CO_2 production in rats fed glucose with or without cortisone (*8*).

TABLE 2.—LIVER WEIGHT, PROTEIN NITROGEN CONTENT, AND C-14 INCORPORATION

Time (hours)		Alanine	Alanine + Cortisone	Lactic acid	Lactic acid + Cortisone	Cortisone	Control
6	A	3.6	3.5	3.7	3.6	3.7	3.5
	B	95	88	87	92	86	90
	C	0.88	1.16	0.88	1.00		
12	A	3.6	3.5	3.5	3.5	3.6	3.6
	B	96	90	90	97	96	94
	C	1.40	2.00	1.28	1.20		
24	A	3.5	3.4	3.7	3.3	3.5	3.4
	B	93	107	92	100	104	96
	C	1.20	1.28	1.00	1.12		
48	A	3.4	3.6	3.5	3.5	3.9	3.4
	B	95	117	94	108	117	98
	C	0.72	1.12	0.60	0.75		
72	A	3.4	3.8	3.4	3.9	4.0	3.3
	B	95	122	98	120	125	104
	C	0.80	1.14	0.40	0.60		

A $\frac{\text{g. liver}}{\text{100 g. body wt.}}$; B $\frac{\text{mg. liver protein N}}{\text{100 g. body wt.}}$;

C $\frac{\%\text{ inc. in liver protein}}{\text{100 g. body wt.}}$

TABLE 3.—INITIAL AND 72-HOUR BODY WEIGHTS AND URINE NITROGEN CONTENT

	Weight		Loss %	Urine N. g.	Urine nitrogen
	Init. g.	72 hrs. g.			100 g. body wt.
Alanine	130	110	15	0.46	0.42
+ Cortisone	116	92	21	0.51	0.55
Lactic acid	126	102	19	0.40	0.39
+ Cortisone	112	86	23	0.39	0.45
Fasting	135	113	16	0.40	0.35
Cortisone	110	86	22	0.42	0.49

There are several possible places where the labeled carbon could have been held and subsequently released, among these are liver protein or lipide, muscle glycogen, protein, or lipide or in the intracellular fluid. The ratio of liver weight to the nitrogen content of the liver protein was greater when cortisone was administered than that of the control that received only DL-alanine or DL-lactic acid. Other investigators have also noted the increase in the protein content of the liver following cortisone administration (*9, 10*). A slight increase at the end of 24 hours in the percent incorporation of the labeled carbon in the liver protein was found following cortisone administration. At the end of 72 hours most of the labeled carbon had disappeared, however the total amount leaving the liver was too small to account for the increase in the specific activity of the liver glycogen. Pesch and Clark (*11*) used the liver slice technic and found that cortisone increased the uptake of labeled glycine into liver protein.

The muscle glycogen content was increased following the administration of cortisone, it reached a maximum value at the end of 24 hours and then decreased, at the end of 72 hours the values were still higher than those found on fasting or with DL-alanine or DL-lactic acid alone. The activity of the muscle glycogen formed at the end of 24 hours was not affected by cortisone but the loss in activity was slightly more rapid following cortisone at the end of 72 hours. The effect of cortisone on the extent of incorporation of the labeled carbon in muscle protein was somewhat more noticeable. At the end of 24 hours the amount incorporated following cortisone was almost half of that found with either DL-alanine or DL-lactic acid alone. At the end of 72 hours there was no labeled carbon left in the muscle protein with cortisone and DL-alanine and only 0.06 percent with DL-alanine alone.

These findings with muscle protein suggest the possibility that cortisone may prevent incorporation of the carbon from the deaminized amino acid residue into muscle protein, thus increasing the size of the pool for glycogen formation. These residues could then return to the liver and be incorporated into glycogen. As a result the specific activity of the liver glycogen would increase as was found, Fig. 1. Marshall and Friedberg

(*12*) have found a decrease in uptake of the C-14 label of carboxyl labeled glycine in the protein fraction of muscle and kidney after giving cortisone. Collateral evidence for this explanation of the increase in specific activity is also found in the data of Tilton, Tonalba, and Ingle (*13*) who gave cortisone acetate subcutaneously to adrenalectomized, eviscerated rats and found an increase in the plasma level of amino acids. These amino acids could come from tissue turnover and reflect the blockage by cortisone of the synthesis of protein in the peripheral tissue.

There was a greater decrease in the protein nitrogen per gram muscle after cortisone administration than on fasting or feeding the labeled compounds without cortisone. Likewise there was a greater decrease in total body weight, Table 4. The total nitrogen excretion during 72 hours per 100 g of body weight was greater following cortisone, averaging 80 mg. per 100 g. Since the muscle contains 3.2 percent protein nitrogen this amount is equivalent to 2.2 g of muscle. The average increase in weight loss induced by cortisone was 5.6 g per 100 g of body weight.

TABLE 4.—MUSCLE GLYCOGEN AND PROTEIN NITROGEN CONTENT, C-14 INCORPORATION

Compound		Time in hours				
		6	12	24	48	72
Alanine	A	0.56	0.56	0.55		0.55
	B	0.12	0.16	0.22		0.15
	C	3.1	3.2	3.2	3.1	2.9
	D	0.03	0.15	0.12	0.10	0.06
Alanine	A	0.57	0.70	0.86		0.70
+	B	0.13	0.21	0.27		0.10
Cortisone	C	3.2	3.2	3.0	2.8	2.7
	D	0.04	0.08	0.07	0.03	0.00
Lactic acid	A	0.55		0.58		
	B	0.10		0.25		
	C	3.4	3.3	3.2	3.2	3.1
	D	0.05	0.10	0.15	0.08	0.06
Lactic acid	A	0.59		0.72		
+	B	0.08		0.32		
Cortisone	C	3.3	3.3	3.0	2.7	2.6
	D	0.06	0.09	0.10	0.03	0.00
Fasting	A	0.58		0.60		0.47
	C	3.2	3.3	3.3	3.1	31
Cortisone	A	0.60		0.70		0.50
	C	3.3	3.0	2.7	2.7	2.6

A per cent glycogen;

B $\frac{\text{per cent C-14 incorporated in glycogen}}{\text{gram muscle}}$;

C $\frac{\text{per cent nitrogen in muscle protein}}{\text{g. muscle}}$;

D $\frac{\text{per cent C-14 incorporated in protein}}{\text{g. muscle}}$

Less than half of the weight loss can be explained by loss of muscle, a concomitant loss of water and perhaps of lipide most probably occurred. Kinsell et al. (*14*) have suggested the possibility that part of the liver glycogen formed by cortisone action comes from body fat.

SUMMARY

Cortisone acetate and 2-C-14 labeled DL-alanine or DL-lactic acid were fed to previously fasted rats for periods of time varying from 1 to 72 hours. Control experiments omitting the cortisone acetate were also run. Liver and muscle glycogen and protein were determined and the degree of incorporation of the labeled carbon was measured. The excretion of the labeled carbon in carbon dioxide and in the urine was also determined.

The carbon-14 from both DL-alanine and DL-lactic acid was rapidly incorporated into the liver glycogen and also rapidly released, peak incorporation was at 8 hours and negligible amounts were left after 16 hours. Cortisone acetate prevented the rapid release of the carbon-14, the specific activity of the liver glycogen increased up to 40 hours and then began to decline. A small amount of the carbon-14 was incorporated into liver and muscle protein. Cortisone increased slightly the extent of incorporation into the liver protein but not the muscle protein. There was no effect upon the elimination of the isotope in the carbon dioxide or the urine.

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HERPETOLOGY.—*Contributions to the herpetofauna of Virginia, 2: The reptiles and amphibians of Northern Neck.* CLYDE F. REED, Baltimore, Md. (Communicated by Doris M. Cochran.)

(Received September 12, 1956)

Northern Neck is the peninsula that lies to the south of the Potomac River and is bounded on the north by that river, on the south by the Rappahannock River, and on the east by the Chesapeake Bay. As the Maryland State line goes to the shore of the Potomac River on the southern side, many of the deep-sea turtles that get up the Potomac River may be considered both as Maryland and Virginia records. Five counties make up the peninsula (from the northernmost to the southernmost): King George, Westmoreland, Richmond, Northumberland, and Lancaster.

The Peninsula is made up of coastal soils only. There are some swampy areas and mill ponds, but for the most part of the land it is dry and woodsy. Several plants reach their northern limit of distribution, west of the Chesapeake Bay, on this Peninsula, as for example *Asarum virginicum* (heartleaves), *Oxydendrum arboreum* (sourwood), and *Galax aphylla* (wandflower).

Since collections of the herpetofauna are rather meager in museums for this peninsula, the author has collected rather extensively in this region for several years. Some species have never been found which undoubtedly are there, as *Hyla cinerea*, *Hyla versicolor*, *Plethodon cinereus*, and the Ambystomas. Descriptions of "swamp puppies" may be Ambystomas, but I have not been able to find any. Large red salamanders with black spots were reported to the author by natives around Moraticco in Lancaster County. While inquiring about toads, the author was told that all the toads vanished some years ago, with apparently no cause. However, in the last few years, they have been reappearing. Both species have been caught on the peninsula by the author.

Deep-sea turtles seem to be quite common off the eastern shores of Northumberland and Lancaster Counties in the Chesapeake Bay and up the lower end of the Potomac River (which would actually be Maryland waters). Capt. Walter J. Biddlecomb of Fairport is a fisherman in this region and reported to the author that several of the sea turtles are very common at certain times of the year. As many as four *Caretta* or loggerheads have been caught at a time in the nets. Three were presented to the author by Captain Biddlecomb from a single catch, along with a Ridley's turtle. A picture of a leatherback caught by Capt. Biddlecomb in 1952 is illustrated herein (Fig. 1). Diamondbacks are fairly common, there being two types as mentioned below.

FIG. 1.—Capt. Walter J. Biddlecomb and son with largest turtle (*Dermochelys c. coriacea*) ever caught in Chesapeake Bay. See listing no. 35, p. 23.

Below is given an annotated list of specimens that have been collected or studied by the author. With more extensive collecting, the several species which should be here may be added in the future.

1. *Hyla crucifer crucifer* Wied—Northern spring peeper. LANCASTER COUNTY: White Stone, July 6, 1948, R. L. Hoffman (U.S.N.M. no. 131939).

2. *Scaphiopus holbrooki holbrooki* (Harlan)—Spadefoot toad. (Fowler, Copeia, 1918, no. 55: 44. Tappahannock, ESSEX COUNTY, which is just across the Rappahannock River from Richmond County.)

3. *Rana clamitans* Latreille—Green frog. LANCASTER COUNTY: 2 miles south of Lively, August 17, 1948, R. L. Hoffman (U.S.N.M. no. 132404); 1 mile north of Moraticco. May 27, 1956, Reed 1047. RICHMOND COUNTY: Ivondale near Farnham, June 5, 1954, Reed 899–904; June 29, 1954, Reed 931 and 988.

4. *Rana palustris* LeConte—Pickerel frog. LANCASTER COUNTY: Kemper's Mill Pond near Kilmarnock, June 5, 1954, Reed 905–906.

5. *Rana catesbeiana* Shaw—Bull frog. LANCASTER COUNTY: Kemper's Mill Pond near Kilmarnock, June 5, 1954, Reed observ.; pond near Lancaster, May 27, 1956, Reed observ.

6. *Bufo woodhousei fowleri* Hinckley—Fowler's toad. NORTHUMBERLAND COUNTY: fields between Reedville and Ophilia, June 9, 1956, Reed 1157–58.

7. *Bufo terrestris americanus* Holbrook—American toad. WESTMORELAND COUNTY: near Chandler's Mill Pond, May 29, 1954, Reed 896.

8. *Desmognathus fuscus fuscus* (Green)—Dusky salamander. KING GEORGE COUNTY: U.S.N.M. no. 45875. RICHMOND COUNTY: Near Village, edge of pond, May 29, 1954, Reed 889. LANCASTER COUNTY: Under log near Chinn's Mill, June 29, 1954, Reed 936. NORTHUMBERLAND COUNTY: Heathsville, May 29, 1954, Reed 888.

9. *Eurycea bislineata bislineata* (Green)—Two-lined salamander. LANCASTER COUNTY: U.S.N.M. nos. 131927–28.

10. *Pseudotriton montanus montanus* Baird—Eastern mud salamander. KING GEORGE COUNTY: Aylett, Dr. Paul R. Burch, Radford College. (See Hoffman, Herpetologica **4** (2): 68. 1947.)

11. *Cnemidophorus sexlineatus* (Linnaeus)—Eastern race runner. LANCASTER COUNTY: Kemper's Mill Pond, on dry hill slopes, plentiful, May 29, 1954, Reed 884. RICHMOND COUNTY: Near Village, July 1955, Reed. WESTMORELAND COUNTY: Observed on sandy slopes, June 5, 1954, Reed; KING GEORGE COUNTY: Near Shiloh, August 10, 1955, Reed observ.

12. *Eumeces fasciatus* (Linnaeus)—Five-lined skink. LANCASTER COUNTY: North of Kilmarnock, May 29, 1954, Reed 891; south of Lively, June 5, 1954, Reed 915. RICHMOND COUNTY: South of Warsaw. June 5, 1954, Reed 916–917. WESTMORELAND COUNTY: Chandler's Mill Pond, June 5, 1954, Reed 909. KING GEORGE COUNTY: Near Shiloh, August 10, 1955, Reed observ.

13. *Eumeces inexpectatus* Taylor—Florida five-lined skink. NORTHUMBERLAND COUNTY: 1 mile north of Heathsville, May 15, 1954, Reed 954 (verified by Walter Newman). (See Reed, Herpetologica, 1956.)

14. *Eumeces laticeps* (Schneider)—Greater five-lined skink. LANCASTER COUNTY: North of Kilmarnock in wood pile, May 29, 1954, Reed 894. KING GEORGE COUNTY: Near Shiloh, Aug. 10, 1955, Reed observ.

15. *Sceloporus undulatus hyacinthinus* (Green)—Northern fence swift. LANCASTER COUNTY: Near Kemper's Mill Pond, May 29, 1954, Reed 890; June 5, 1954, Reed 908; south of Lively, June 5, 1954, Reed 907. NORTHUMBERLAND COUNTY: South of Wicomico Church, May 29, 1954, Reed 885–886; 1 mile north of Heathsville, May 29, 1954, Reed 892–893. RICHMOND COUNTY: Near Haynesville, May 29, 1954, Reed 887; south of Warsaw, June 5, 1954, Reed 918; near Village, July 10, 1955, Reed observ. KING GEORGE COUNTY: Near Shiloh, August 10, 1955, Reed observ.

16. *Natrix sipedon sipedon* (Linnaeus)—Common water snake. WESTMORELAND COUNTY: Chandler's Mill Pond, north of Montross, August 10, 1955, Reed observ.; Dunn, Copeia, 1918, no. 53: 25.

17. *Opheodrys aestivus* (Lumaeus)—Rough green snake. LANCASTER COUNTY: U.S.N.M. no. 131930. NORTHUMBERLAND COUNTY: Climbing over shrubs, south of Wicomico Church, May 29, 1954, Reed 895. WESTMORELAND COUNTY: Chandler's Mill Pond, north of Montross, August 10, 1955, Reed observ.

18. *Elaphe obsoleta obsoleta* (Say)—Pilot black snake. WESTMORELAND COUNTY: Hampton Hall Creek, May 29, 1954, Reed; Chandler's Mill Pond, north of Montross, August 10, 1955, Reed observ. RICHMOND COUNTY: At Ivondale near Farnham, June 29, 1954, Reed observ. KING GEORGE COUNTY: Near Shiloh, 6–7 foot long, August 10, 1955, Reed observ.

19. *Elaphe guttata guttata* (Linnaeus)—Corn snake. WESTMORELAND COUNTY: Hague, DOR, May 27, 1956, Reed 1046.

20. *Coluber constrictor constrictor* Linneaus—Black racer. KING GEORGE COUNTY: Oak Grove,

DOR, June 9, 1956, Reed observ.; DOR, south of Potomac River Bridge near Dahlgren, June 9, 1956, Reed 1156.

21. *Thamnophis sauritus sauritus* (Linnaeus)—Eastern ribbon snake. LANCASTER COUNTY: Near Lancaster, climbing over shrubs along creek, June 29, 1954, Reed 935.

22. *Carphophis amoena amoena* (Say)—Eastern worm snake. Shore of Potomac, Virginia, U.S.N.M. no. 59954.

23. *Storeria dekayi dekayi* (Holbrook)—De-Kay's snake. RICHMOND COUNTY: Ivondale near Farnham, June 5, 1954, Reed 913.

24. *Storeria occipitomaculata occipitomaculata* (Storer)—Red-bellied snake. LANCASTER COUNTY: South of Lively in sawdust pile, June 5, 1954, Reed 914; shed skin, June 15, 1954.

25. *Heterodon platyrhinos platyrhinos* Latreille—Hog-nosed snake. KING GEORGE COUNTY: Near Shiloh, August 10, 1955, Reed observ.; Dunn, Copeia, 1918, No. 53: 25. WESTMORELAND COUNTY: Chandler's Mill Pond, north of Montross, August 10, 1955, Reed observ.

26. *Ancistrodon contortrix* (Linnaeus)—Copperhead. WESTMORELAND COUNTY: Reported by natives from Chandler's Mill Pond region, north of Montross, August 10, 1955 (Reed).

27. *Terrapene carolina carolina* (Linnaeus)—Common box turtle. KING GEORGE COUNTY: DOR, near Potomac River Bridge, June 10, 1956, Reed observ.; near Osso, August 10, 1955; 3 miles west of King George, August 10, 1955, Reed observ. WESTMORELAND COUNTY: Oak Grove, June 10, 1956, Reed observ.; west of Montross, June 10, 1956, Reed observ.; south of Oak Grove, May 29, 1954, Reed 882. NORTHUMBERLAND COUNTY: Near Burgess Store, May 29, 1954, Reed 880; near Remo, May 27, 1956, Reed observ. LANCASTER COUNTY: Near Lancaster, May 27, 1956, Reed observ.

28. *Lepidochelys kempi* (Garman)—Ridley turtle. NORTHUMBERLAND COUNTY: Reedville, U.S.N.M. no. 86814; 3 miles off Great Wicomico Lighthouse, in Chesapeake Bay, June 6, 1956, Capt. Walter J. Biddlecomb collector. Specimen donated to the U.S.N.M. (no. 137573) by Reed, 31 pounds.

29. *Chelydra serpentina serpentina* (Linnaeus)—Snapping turtle. NORTHUMBERLAND COUNTY: Village, crossing road, May 27, 1956, Reed observ. WESTMORELAND COUNTY: South of Oak Grove, May 29, 1954, Reed 881; near Colonial Beach, May 15, 1954, Reed 855. LANCASTER COUNTY: Near Lancaster, June 29, 1954, Reed observ.

30. *Chrysemys picta picta* (Schneider)—Eastern painted turtle. NORTHUMBERLAND COUNTY: Mill pond 4 miles east of Callao, June 29, 1954, Reed 932; north of Heathsville, May 29, 1954, Reed 878–879. WESTMORELAND COUNTY: South of Oak Grove, May 29, 1954, Reed 882; DOR, just west of Potomac Beach, June 10, 1956, 6 observed on logs in pond, Reed observ.; near Maple Grove, August 10, 1955, Reed observ. LANCASTER COUNTY: Near Lancaster, June 29, 1954, Reed observ. KING GEORGE COUNTY: DOR, near Potomac River Bridge, June 10, 1956, Reed 1065; just north of Maple Grove, August 10, 1956. Reed. RICHMOND COUNTY: Ivondale near Farnham, June 5, 1954, Reed 912.

31. *Sternotherus odoratus* (Latreille)—Common musk turtle. NORTHUMBERLAND COUNTY: North of Heathsville in pond, May 29, 1954, Reed 897; LANCASTER-RICHMOND COUNTY Line: Chinns Mill. June 29, 1954, Reed 934.

32. *Kinosternon subrubrum subrubrum* (Lacépède)—Common mud turtle. NORTHUMBERLAND COUNTY: North of Heathsville in pond, May 29, 1954, Reed 898; same locality, June 5, 1954, Reed 911; 4 miles east of Callao, June 29, 1954, Reed 933. LANCASTER COUNTY: Near Lancaster, June 29, 1954, Reed observ. WESTMORELAND COUNTY: Dunn, Copeia, 1918, no. 53: 20.

33. *Malaclemys terrapin terrapin* (Schoepff)—Northern diamondback terrapin. NORTHUMBERLAND COUNTY: Off Fairport, Capt. Walter J. Biddlecomb, observ., 1956.

34. *Malaclemys terrapin centrata* (Latreille)—Southern diamondback terrapin. WESTMORELAND COUNTY: Near Machadoc, U.S.N.M. no. 65117. Carr gives the range as "vicinity of Cape Hatteras southward to southern peninsula of Florida"; Schmidt gives the same range. Captain Biddlecomb, who has collected in the mid-Chesapeake Bay for many years, states that there are two types of diamondbacks which he catches off Fairport, Northumberland County, Va. This would indicate that both subspecies live in the lower Chesapeake Bay.

35. *Dermochelys coriacea coriacea* (Linnaeus)—Leatherback turtle. NORTHUMBERLAND COUNTY: 2 miles southeast of Great Wicomico Light House, near Fairport, May-June 1952, Capt. Walter J. Biddlecomb collector (June 7, 1952, *Richmond News Leader*), 700 pounds, 7 feet long, 8-foot flipper span. Fig. 1.

36. *Caretta caretta caretta* (Linnaeus)—Atlantic loggerhead turtle. NORTHUMBERLAND COUNTY: 3 miles off Great Wicomico Lighthouse, near Fairport, June 6, 1956, Capt. Walter J. Biddlecomb collector. Three specimens caught and observed. Two weighed about 110 pounds each and let go. The third specimen weighed 134 pounds, donated to U.S.N.M. (no. 137572) by Reed.

ZOOLOGY.—Spongilla discoides *Penney: A correction.* JAMES T. PENNEY, University of South Carolina. (Communicated by Fenner A. Chace, Jr.)

(Received October 9, 1956)

The identification of *Spongilla discoides* Penney (1933a) as a new species was based upon the presence of gemmules in the shape of biconvex discs, the absence of gemmule spicules, the presence of small equibirotulates (microscleres) in the dermal membrane, and the presence of two types of flesh spicules (also microscleres) in the tissue. Specimens containing these gemmules were first collected in 1930, and many others were obtained for four or five years afterward. They were extensively used in reduction experiments (Penney, 1933b). The same sponge, without gemmules, was used for routine class experiments and in dermal membrane studies for many years. Most of this work was conducted during the spring and summer and no attempt at year round collecting was made. No gemmules were observed during this period. The pond from which this sponge was collected has been dry for the last two years.

Recent collections from various areas within South Carolina have yielded specimens in close association with bryozoans. The presence of the latter led to the idea that the gemmules of *Spongilla discoides* may have been statoblasts of a bryozoan. The United States National Museum was requested to send my slide of the "gemmules" of *Spongilla discoides* to a competent authority on the bryozoa. Dr. Mary D. Rogick identified these "gemmules" as statoblasts of a phylactolaematous bryozoan.

Many hundreds of young sponges of this species have been reared on slides in the laboratory from adult specimens by a method described earlier (Penney, 1932). All distinctive characters listed above with the exception of gemmules and absence of gemmule spicules were constantly observed. It was noted in the original description (Penney, 1933, p. 4) that the two types of flesh spicules resembled closely the gemmule spicules of *Heteromeyenia ryderi* and that a new genus was possibly indicated.

Jewell (1952) remarked upon the similarity of the birotulate dermal spicules to those of *Corvospongilla* and *Corvomeyenia* and also the similarity of the two types of flesh spicules to the birotulate gemmule spicules of *Heteromeyenia ryderi*. Jewell also stated that on several occasions typical gemmule birotulates had been found "embedded in the flesh, when no gemmules were present, in both *Corvomeyenia everetti*, and *Heteromeyenia ryderi*. It is possible that the scleroblasts had formed these spicules in anticipation of the development of gemmules around which they would later have been arranged, or that some condition inhibited the development of gemmules without equally affecting the formation of the spicules which should surround them" (p. 454). This writer has also observed free gemmule spicules in *Heteromeyenia ryderi*. Owing to the lack of gemmule spicules and the close similarity of other spicules to those of the subfamily Meyeninae, Jewell very soundly established the genus *Parameyenia*, with *Spongilla discoides* Penney, 1933, as genotype.

Weltner (1913) created the genus *Corvomeyenia* for the species of *Heteromeyenia* having birotulate dermal spicules.

With the knowledge that *Spongilla discoides* is now without known gemmules, that it does have birotulate dermal spicules, and on the basis of Jewell's and my own observation of free gemmule spicules, I propose that *Spongilla discoides* become *Corvomeyenia discoides* (Penney).

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1419TH MEETING, DECEMBER 16, 1956

JOHN R. MAYER, of the American Association for the Advancement of Science and the University of Wisconsin, spoke on *Scientists and the secondary schools.*

His talk ranged widely, with abundant quotations, over a number of aspects of the problem of getting enough good teachers and enough attention to the superior student in the secondary schools. Some of the points made were: In reply to the State Department of Education head, who said: "We get better teaching if we employ those who are not too good," he suggested that we have to find teachers who are able to help all three groups: backward, average, and superior, and that currently there is little challenge to the better student. He urged the necessity for a diversified program, one that would treat better students differently, and replied to the criticism that this was "undemocratic" with the argument that in Speech, Dramatics and Athletics, we give special treatment with no thought of invidious implications. Why should not Science be special in this sense too?

In his view we have done a better job of providing a general education for more people than ever before in the world's history, particularly in finding common ground for the gifted and the less gifted, and in doing more for the backward.

He pointed out that the many new offerings in the secondary schools compete with Science when course elections are to be made. In the AAAS program, the first responsibility for improving science teaching in secondary schools lies with the science department of universities and colleges. They have to a large extent abdicated this responsibility. Teacher education of science teachers must be their function. Too many in summer schools elect Education rather than Science. He would like to see all teachers have MA's in their respective subjects: this is now impossible but should be the ideal.

Our pressing current problem is better education for the more gifted. He quoted Lippmann: America is now rich enough to do both; that is, give a general education to all and special treatment to gifted. He also touches on the interesting development called "Frontiers of Science" now in progress in Oklahoma, and closed with a quotation from the Illinois Chapter of the Mathematics Association of America: "Knowledge and the Wisdom to use it are essential to survival".

In the discussion, Messrs. Potter, Tuckerman, Eisenhart, Henderson, Melton, Frenkiel, Page, Rotkin, Lashof, and others took part. Some of the points made were: that current mathematics texts may be seriously in error: that primary school teaching in mathematics is wretched and that the abominations contained in the texts are past belief; and that it is always possible to give instruction but never to give brains. Questions asked were: What are the reasons for students not taking algebra as much as they used to? Are the teachers not there or have they lost interest by the time they get to it? Mayer answered that this is not known but that schools were trying to meet the slump by providing two-track courses: (1) General Mathematics for the 7th and 8th grades, and (2) Algebra for those able and ready for it. Mr. Eisenhart noted that he was glad that Universities are now providing programs for future teachers different from those provided for men going in for stochastic processes or Hilbert space. He also urged that teachers should be checked as to their continued performance, and that good teachers should be used for freshman. "Should we turn out teachers or abstract papers?" What are the motivations of teacher candidates? Why do they enter, or more often, not enter the profession? Answer: We do not yet know.

It was pointed out that many scientists, or potential scientists were "lost before the sixth grade".

A brief notice was given of the program for replacing the science teachers for two days, during the Science Teachers' Conference here in Washington. (*Secretary's abstract.*)

1420TH MEETING, JANUARY 13, 1956

LAURENCE A. WOOD, of the National Bureau of Standards, delivered the retiring president's address, *Elasticity of rubber*. The following is the abstract provided by Mr. Wood. "Rubbers, natural and synthetic, are unique in being highly extensible and in retracting forcibly and quickly to substantially their original dimensions when released.

"It has been found that the stress-strain curves for extension and compression of most of the simplest vulcanizates of natural rubber and of the three most important synthetic rubbers are similar in shape. The relationship is expressed by the equation $F/M = (L^{-1} - L^{-2})X \exp(A \cdot (L - L^{-1}))$. where F is the stress, L the ratio of stretched to unstretched length, and M and A are constants. The constant M depends on the nature of the rubber, the extent of vulcanization, and the time of creep. The constant A has a value of about 0.38.

"By the study of the stress-temperature relations it is found that the most important factor in the retraction of stretched rubber is the tendency of long-chain flexible molecules to return to a configuration statistically more probable than the one that the stretching has forced them to assume. Calculations of entropy changes arising from stretching can be made from probability considerations, and a strain-energy function deduced from the entropy changes. Stresses calculated from the strain energy function agree with those observed in compression, but are greater than those observed in extension by almost 50 per cent at L equals 3.

A phenomenological approach shows that the strain energy should be expressible as a function of certain quantities called strain invariants, calculable from the deformations. The simplest behavior is found in the region of compression (L less than 1), where the strain energy is merely the first invariant times a constant calculable from the entropy changes. For values of L between 1.5 and 3, a different constant and an added term involving the second strain invariant are required. The explanation of this behavior in molecular terms is one of the most important current problems of rubber elasticity."

1421ST MEETING, JANUARY 27, 1956

ROBERT M. PAGE of the Naval Research Laboratory spoke on *Cosmological theories ancient and modern*. The address has been published in this Journal **46:** 244–252. 1956.

1422D MEETING, FEBRUARY 10, 1956

JOSEPH KAPLAN, of the University of California at Los Angeles and chairman of the U. S. National Committee on the IGY, read a paper on *The International Geophysical Year program of the United States*, commonly called the IGY.

International cooperation in the study of man's Physical environment is not new, as witness the first International Polar Year in 1882–83 and the Second IPY in 1932–33, but in scope, intensity, wide-ranging geographical coverage extending not only horizontally but vertically to unprecedented heights (and incidentally in cost) the 1957–58 international effort surpasses them by orders of magnitude.

The year 1957–58 was proposed as the date of this effort because a period of maximum solar activity is expected then, and world-wide coordinated efforts to measure the many effects to be expected therefrom can best be carried out through such an activity as the IGY. Historically, the story of the IGY goes back 5 years and to meetings of the International Union of Geodesy and Geophysics and of the International Scientific Radio Union. These Unions recommended that the International Council of Scientific Unions do the technical planning. Following this lead the ICSU has established a special committee, and appropriate bodies in cooperating countries have been called upon to plan their national programs. In the USA the National Academy of Sciences has established the National Committee for the IGY, and this committee has the responsibility. Funds have been provided by congress through the National Science Foundation: so far in the amount of $12,000,000. At least twice as much more will be required in the scientific program alone before the collection of data is completed.

Within the scope of these minutes it is impossible to do much more than list the current projects and programs in which the United States is interested. They are as follows: Aurora and Afterglow, Cosmic Rays, Geomagnetism, Glaciology, Ionospheric Physics, Longitude and Latitude Determinations, Meteorology, Oceanography, Seismology and Gravity, Solar Activity, and Upper Atmosphere Rocket and Satellite Studies. Each of these topics was discussed briefly and the high lights of the programs described. Of particular interest was a description of the proposed satellite vehicle and the program involving it, which goes under the same name of "Project Vanguard". This pioneering venture involves launching a 21.5 pound satellite vehicle by means of a three-stage rocket assembly which will carry the vehicle to 300 miles before propelling it into its orbit to circle the earth at 18,000 mph, or once around the earth in 1½ hours. An elliptical orbit, inclined at about 40°

to the equator is anticipated, and the orbit will precess forward around the earth about 25° per revolution, while it covers all latitudes from 40° N to 40° S. The satellite will be tracked during its flight and will at times actually be visible to the naked eye.

Half the satellite's weight will be instrumentation including the telemetering system. Eight experiments will be undertaken: air density, composition of the earth's crust and geodetic determinations, temperature and pressure, meteor observations, studies of the extreme ultraviolet and cosmic ray intensity.

It is proposed to launch about 10 such satellites, with the hope that at least five or six will be successful.

From the program as a whole the speaker anticipates startling discoveries, and an immense body of data. Its digestion will take years and tax even the newest systems for handling it. The practice in cooperation gained in this field may lead to more cooperation in other fields, and a longed-for reduction in international tension.

In the discussion Messrs. McNish, Melton, Tuckerman, Heilbron, Yagoda, Sangster, and several other took part. Points were: On the question of cost, the total over-all cost is, of course, much in excess of $40 million if all expeditions and the like are charged to the IGY. Much of the satellite's time will be spent over uninhabited country. The orbit will be elliptical "Because we probably can't make it circular." The weather balloon program is not part of the IGY. Agreements to exchange data, when made in advance, are usually kept. The USSR has not announced a rocket or satellite program of her own. The life of the satellite may lie between 2 weeks and a year or so; we don't know the density of the air well enough to predict it. There is no diplomatic problem here. About 2000 people will be directly engaged on the IGY in the USA. And there will probably be different shapes of satellite, after the first spherical one. (*Secretary's abstract.*)

1423D MEETING, FEBRUARY 24, 1956

T. H. SIMPSON, of the U. S. Weather Bureau, spoke on *Aircraft instrumentation and recorders for hurricane investigation.*

The hurricane (including all storms of its type however called: such as willi-willi, typhoon, tropical storm, cyclonic storm, or equinoctial gale) is the greatest geophysical killer we have. In its life of 8 to 10 days covering areas of diameter of 3-400 kilometers, and traveling thousands of miles, it dispenses energy in the neighborhood of 300 trillion (3×10^{14}) KWH. How it draws on the available energy of the atmosphere is a fascinating problem, as well as one of immense practical importance. The cooperation of the Air Force, Navy, and the Special Services has borne fruit in the "National Hurricane Research Project," with the objective of understanding the formation, mechanics and movement of these storms, ultimately with the hope that some modification in their course or intensity may be achieved.

The energy of hurricanes is provided in two ways: by the spreading and sinking of airmasses, releasing potential energy, as in a cold front, and secondly, and predominantly, by the release of latent heat in the rising and condensation of moist, warm air. The latter is recognized as primary, but at the same time other energy is fed in from anti-cyclones in the east to north to northwest sector. If this supply fails the storm dies very rapidly.

Several slides of wind directions in the course of Edna, and of the seas, wind force and track of typical storms were shown. It is apparent that the track of such storms is not a monotonic curve, but has wobbles of considerable amplitude. These wobbles make detailed prediction of course very difficult, but since the inundation caused by the hurricane is the "real killer", and this occurs only in a path of limited width, precise prediction is vital. We must know the internal forces.

An extensive description of the organization and instrumentation of the project followed. It is proposed to use Aircraft, balloons, and rockets in the data collection program. There will be photographs of the entire cloud system from 50 to 100 miles up using rockets; also balloons to 85–90,000 feet and aircraft at three levels 1,000 to 1,500, 15–20,000, and 30–42,000 feet; 2 B-50s and a B-47 are used. From the data collected by these agents, it is hoped to construct the complete "energy budget" of the storm.

For navigation the APN-82 automatic Doppler radar observes and computes position continuously and automatically, gives the wind speed and direction, and punches the data on a punch card every 0.1 mile. PPI search radar scopes photographed continuously, show the "rain bands". For temperature there are three types of thermometer: vortex, aspirator, and stagnation.

(The problem here is to get a dry bulb temperature in the midst of a tropical downpour.) For humidity, the infra-red airborne hygrometer, using the H_2O absorption band is the instrument of choice. For pressure, the radar altimeter is continuously checked against the pressure altitude.

There are vertical and horizontal accelerometers, time lapse cloud cameras, sea-surface-temperature measuring instruments, cloud physics instruments to measure icing, nuclei, electric charges and fields, and other things; and a battery of recorders beginning with a standard movie camera and including a photopanel with 24 channels to record all navigation and meteorological data as a back-up system to the Heiland Recorder, and the IBM Digital Recorder with 5-23 Gang punch and Card Program Computer. With this array of devices it is possible to process the data from three planes in 24 hours.

We do not know explicitly what makes the hurricanes move, nor how fast. If more heat is produced in some area ahead of the storm there will be more circulation through it and a reduction in pressure, and the storm will then move that way. If we could release the energy in a selected area we might move the storm a significant amount. Possibly through the use of "freezing nuclei" it may be possible to do this. There are of course always plenty of condensation nuclei.

In discussion Messrs. Mahan, Page, McNish, Tuckerman, Frenkiel, Henderson, Mason, Steeler, and others took part. The influence of land masses in cutting off the supply of latent heat; the circulation of tornadoes, particularly anticyclonic ones; the controversy as to whether air goes up or down in a tornado; laboratory models of tornadoes, eye and all; and the proper way to approach the center of a hurricane by air were points discussed, if not exactly settled. Others were the use of AgI and dry ice as nuclei, the absence of cycles in weather, and Wexler's theory involving the increasing cleanness of the atmosphere owing to the lack of a renewed supply of volcanic dust since Krakatoa and the accompanying increase of solar constant. (*Secretary's abstract.*)

1424TH MEETING, MARCH 9, 1956

Z. I. SLAWSKY, of the Naval Ordnance Laboratory, spoke on *High speed gas dynamics.*

What happens when the impact forces between molecules are so great that they no longer act as rigid spheres? These forces can arise at high Mach numbers. Here we should distinguish between real Mach numbers at room temperature, and the so-to-speak "fake" Mach numbers of a wind tunnel, where the expansion has lowered the temperature to such a degree that the velocity of sound is much reduced. Small nylon spheres, 8mm in diameter, are fired at 10⁶ ft/sec into various gases. A luminous zone in front of the missile appears at Mach 17 in Xenon. The shock wave can be photographed, even though the velocity is 3 mm/microsecond, and the distance from missile to shock front measured. If there is ionization, or other means of absorbing the energy, the shock moves closer to the missile. Slides of the shock in Bromine at Mach 17.5 were also shown.

A theoretical discussion of the limits of gun performance shows that guns are hard to improve, as is always the case with devices that are historically old, and shows also that there are limiting muzzle velocities for any propellant no matter how much is loaded in the chamber. The best propellant has the lowest "ρc" i.e. acoustic impedance, and the highest temperature. The maximum velocity an air gun can produce is about 5500 ft/sec. Knowing the velocity of a projectile at any point in its flight as it is being accelerated in a gun gives a measure of the "ρc" of the propellant and thus of thermodynamic properties.

By using a microwave radar interferometer the position and time can be measured every 3½ mm for 200 stations. The propellant giving best performance is "steam heated helium," i.e., helium with oxygen and hydrogen added in explosive proportions, and then touched off with a spark. With this propellant, a 40 mm nylon bullet has been accelerated to 11,000 ft/sec. 15,000 is expected to be the maximum attainable.

Question and comments were offered by Page, Henderson, Hersey and several others. Measurements are made from the muzzle end, and the barrel is partially evacuated. The shock wave in the remaining gas breaks the vacuum seal, permitting the bullet to emerge undistorted by any impact. Xenon was used in order to make a study of ionization uncomplicated by dissociation. In general the energy in the shock is distributed in a complicated way between dissociation, ionization, and excitation.

Informal Communications: Mr. Potter asked Mr. Tuckerman to report on the talk given that morning by Mr. Synge at the NBS, on the subject of the meaning of Time and Space. Mr. Tuckerman obliged.

Mr. Henderson reported on the hearings before the Sub-committee on Government Information of the Committee on Government Operations, at which the question of the impact of secrecy upon scientific progress was under examination.

Mr. Potter reported on a book by Synge, *Science: Sense and Non-sense*, and gave a brief account of some of his own space models.

Mr. Tuckerman commented briefly on the inadequacies of modern education, and the small amount of science, and most of it wrong, that youngsters are expected to learn.

Mr. Frenkiel reported on the winners of the Westinghouse science awards.

Mr. Brode noted that the offspring of multiple births, of order M, and inherited brain N, do not have brain power of order N/M. (The speaker and Mr. Brode are both members of identical twin pairs.)

The Secretary commented that, in his experience, the number of informal communications at the meeting was an all-time record: namely 6. (*Secretary's abstract.*)

1425TH MEETING, MARCH 23, 1956

F. G. BRICKWEDDE, of the National Bureau of Standards, and a Past President of the Society spoke on *Temperatures in atomic explosions.*

A great deal of information concerning the sequence of growth of the "fireball" and the transfer of energy therein may be obtained classically. The "fireball" is the familiar luminous mass of air formed after a nuclear detonation. For a "20 kiloton bomb" it reaches a radius of about 500 feet.

Nuclear explosions are remarkable because of their difference from chemical explosions. Incredibly high temperatures and pressures arise in the tiny volume occupied by the fissioned substance. The energy release per cm³ of TNT is about 1.45×10^3 cal/cm³ whereas for U^{235}, or Pu^{239}, it is about 3.5×10^{10} cal/cm³.

TNT and U^{235} have ordinarily about the same specific heat, 0.3 cal/cm³, hence the temperatures that might be expected upon their detonation, calculated from $C_v = \Delta H/\Delta T$, are 6000°K and 100 billion °K respectively. A TNT explosion actually reaches 5000°K, but with nuclear detonations the value is about one thousand times less than expected: i.e. only about 50 million degrees K. Reversing the calculation one therefore finds an apparent specific heat of about 600 cal/cm³ for the nuclear material. This large value is due to the large number of degrees of freedom which are provided by over 80 free electrons per fissioned atom, and to the large heats of excitation and ionization of the fragments.

At the enormous temperatures of nuclear explosions the principal mode of energy transfer is by radiation processes. The interior of the ball of fire is in thermal equilibrium owing to the high speeds imparted immediately to the atoms of the engulfed atmosphere. The wavelength of maximum energy density is 3 Å, hence the photons are absorbed so soon after their emission that the propagation is by diffusion of photons. At a later stage of fireball growth the radiation energy propagation is actually slower than the propagation of the pressure shock. This fact has an interesting consequence.

There are three stages of growth of the "fireball." The first is dominated by the radiation conditions in the isothermal sphere. As the pressure shock passes the boundary of the isothermal sphere it now heats the atmosphere. The heating is great and so the pressure front is luminous but the temperature of the shock heated air is not as high as the temperature of the isothermal sphere inside the shock front. As the "ball of fire" grows the temperature of the pressure shock decreases and "breakaway" occurs; the pressure shock continuing its advance but not luminously. After a short time the expanding iso-thermal sphere reaches the outer surface of the fireball and is once again seen and appears more brilliant ($T \sim 7500$°K) than the second stage ($T \sim 2000$°K). The times involved are exceedingly short, "breakaway" occurring one hundredth of a second after detonation.

Ten slides were shown illustrating these points and developing the simplified model of the complex process dominated by radiation properties of space.

Comments and questions were offered by Montroll, Henry, Maxwell, McNish, Shuler, and others. In the diffusion of radiation the mean free path may be of less importance than the "sitting time" of photons in the atoms and results in radiation imprisonment. For atomic explosions at high altitudes the rarified atmos-

phere would change the character of the explosion fireball as would underwater explosions in the relatively dense medium. The tremendous energy gap between chemical and nuclear explosions, tenths of electron volts versus 100 million volts indicates an improbable if not impossible solution for tapping energies of intermediate values. It would be interesting to calculate the rate entropy is produced in the ball of fire as well as the thermodynamic quantities presented by the speaker.

After announcing the speaker for the next meeting, the spirited but sober discussion was adjourned for beer and other refreshments.

All data from the AEC unclassified public report: "The Effects of Atomic Weapons." (*Secretary's abstract.*)

1426TH MEETING, APRIL 6, 1956

H. P. BROIDA, of the National Bureau of Standards, spoke on the *Stabilization of free radicals at low temperatures.*

A "free radical" is an unstable chemical substance which lasts usually a very short time and which is very reactive—combining with itself and with other things. It is easier to give examples such as nitrogen atoms, NH, CH_3, etc., than to define quite what is meant by such a substance. Reaction rates are very temperature dependent: since at low temperatures the velocities and the particle collision frequencies are both reduced. It should therefore be possible to, in a sense, "freeze" free radicals so that they do not react, or at least react so much more slowly that they can be studied at relative leisure. It proves possible to do this at liquid helium temperatures.

A dramatic demonstration of the actual research apparatus was given by the speaker and his assistants, in which nitrogen, after bombardment in a glow discharge tube run by a 2450 MC radar generator, was collected on a surface cooled by liquid helium. Various phenomena, not always predictable, were observed, including various green glows, colored flashes, and exponential decays. Unobservable by the audience, but vouched for the speaker, were radiations in the near infrared and ultraviolet, as well as considerable amounts of heat. Calculations from the heat released showed that the order of 10% of the nitrogen condensed as atoms in the solid state. Their recombination to molecules then produced the various phenomena.

Several slides of the spectra of nitrogen discharges and afterglow were shown for comparison with the actual spectra from the tube. One strange result is that the solid nitrogen gives many sharp lines, an unusual phenomenon for a solid. The doublet *D* and the quintet sigma levels account for some of the bands observed, but the Wegard-Kaplan bands are not seen. The tentative explanation advanced is that the green comes from the ^2D to ^4S atomic nitrogen transitions. The origin of the yellow lines is not known. The blue is molecular nitrogen $^5\Sigma$ to $^3\Sigma$ and the *UV* from *NO* gamma and beta in the solid.

Other gases have been tried, and a very efficient means of producing ozone was discovered, having a yield of nearly 30 per cent. Absorption spectra of the solids have been photographed, and they show sharp absorption edges. In the case of hydrogen it was found that while molecular hydrogen is solid and opaque, atomic hydrogen is clear and viscous. Water vapor gives two different solids, and some HO_2.

The work should be of significance in the understanding of the solid state, will increase our knowledge of reaction kinetics, and may lead to new products with commercial possibilities.

In discussion Mr. Kaplan pointed out that Wegard's bands would not be expected, that there might be O_2 bands in the infra red, and that there is a problem in the understanding of quintet sigma levels. Mr. McNish mentioned the history of aurorae and Wegard's postulate of glow from frozen N particles, and also Babcock's work on oxygen. Mr. Burstein asked if these free radicals are the same as those postulated by G. N. Lewis in solution. Mr. Tuckerman asked if this was nascent nitrogen, in the old-time sense. Both answers were yes. Mr. Herzfeld commented on the auroral problem. Mr. Maxwell asked about the production of O_3 and H_2O_2, and suggested that the measurement of paramagnetic susceptibility might prove useful. Mr. Shuler asked about the NH radical, and Mr. Rice commented on its discovery in his laboratory, which he made sound somewhat informal. (*Secretary's abstract.*)

1427TH MEETING, APRIL 20, 1956

SIR GEORGE P. THOMSON, Master of Corpus Christi College, Cambridge, England, delivered the 25th Joseph Henry Lecture, on the subject *Atomicity and patterns.* The address has been published in this Journal **46:** 201–205. 1956.

1428TH MEETING, MAY 4, 1956

TERRILL HILL, of the Naval Medical Research Institute, Bethesda, Md., spoke on *A model for muscular action on a molecular level.*

The speaker's colleagues, Messrs. Moralis and Botts, have suggested a scheme to account for muscle action and the speaker's contribution has been in making the relations quantitative. The picture they propose is that the contractile forces come from the configurational entropy of long chain protein polymers and from electrostatic forces within them.

It is well known that the basic contractile material in muscle is the protein myosine: a long chain molecule whose component amino acids are known as to quantities, not as to actual arrangement. Myosine itself has a net negative charge, when in biological materials at pH 7, but the magnesium ions that are always present, cancel this negative charge and leave a net positive charge of one unit for each ninth amino acid.

The other component in muscle action is Adenosine triphosphate, a compound of adenine and a five-carbon sugar plus three phosphate molecules; known as ATP. ATP has nearly 4 negative charges per molecule. ATP is unstable relative to the di-phosphate, ADP, with a reaction energy of 7 to 8 KCal per mole, but the reaction rate is negligible at pH 7. There is in fact a resonance between the two.

Now myosine is an enzyme for this reaction. ATP is believed to be the source of most of the free energy for biological processes, and this energy does the mechanical work of contraction. How the release becomes contraction is the problem to be solved.

Proteins have molecular weights of 70,000 within one power of ten, so there are hundreds of amino acids per chain. Each acid can be oriented in almost any direction with respect to its neighbor, so in calculating the average length of a protein molecule we have the statistical "random walk" problem, and the most probable configuration turns out to be a short one. Short but not zero, since space is filled up by the chain itself. An electric charge on the parts of the protein molecule will tend to counteract this tendency toward shortness. The Moralis and Botts picture is that a relaxed protein at rest has a net charge, furnished by Mg^{++}, and the ATP is remote from it. On contraction the ATP attaches itself to the Mg, cancelling the charge and causing the protein to seek a shorter configuration and its lowest entropy. The enzyme action of the myosine then splits the ATP into ADP, which is not so closely bound to the myosine, and it goes back into solution as ADP and P while the molecule extends again. In this cycle mechanical work has been performed. The ATP is then reformed through the burning of fuel in the body of the muscle.

While this proposed mechanism seems simple, it is highly controversial. It is not known just when the work is done, and there is a question whether a real change in length can occur through a change in charge. A relation between length and tension is needed both with and without charge. In a muscle fiber the change in length is the order of 2:1.

The speaker has carried out calculations of the Helmholtz free energy A, as a function of l, V, and N (length, volume, number of ions) on two different pictures of the structure of the fiber: one a random mass of molecules, the other a 'combed" structure, in which all molecules lie roughly parallel. The calculations can be done in steps, from the dry protein, uncharged, through 1) solution in water, 2) binding ions on the protein, and 3) charging it. We then get A, and dA/dl is T. Curves for both models were shown. The "combed" or "accordion" model gives the greater sensitivity to charge change because it permits a type of "phase change" familiar to workers with high polymers. In any case the proposed mechanism seems to provide adequate extension and contraction.

In the discussion Messrs. Henderson, Green, Duryee, and several others took part. The resemblance to the theories of the elasticity of rubber was noted. The proposal of Flory, that muscular action represents a change from random to regular array, was mentioned. Other points were: that the enzymatic action is fast, that myosine has been studied in thread form at low temperatures, that other ions such as bromine will cause contraction too.

It is not known whether this model will account for the extreme rapidity of insect wing's motion or not. And lastly, calcium is being studied as one of the "relaxing factors," since one alternative theory is that ATP is already bound and the muscle is relaxed by calcium ions. (*Secretary's abstract.*)

1429TH MEETING, MAY 17, 1956

At this joint meeting with the Washington

Academy of Sciences, GEORGE WALD, of Harvard University, delivered an address on *The mechanism of quantum sensitivity*. This address continued the program of the Academy, which had been devoted to the quantum aspects of vision during the afternoon.

After a skillfully adapted paraphrase of "I come to bury Caesar, not to praise him"—Caesar being the photochemical theory of vision—and the whole speech ironical in intention, a series of slides showing the physiology and biochemistry of the eye was shown. The relations between vitamin A, retinene, and the various "—opsins" was carefully sketched out. The synthesis and the bleaching of rhodopsin and iodopsin is the first reaction in line: admittedly vision is a great deal more than this, but the whole physiology of vision depends upon it.

The spectral sensitivity of vision as a function of light intensity is determined by the differing absorption spectra of rhodopsin and iodopsin. That is to say, scotopic (dim light) vision has a different sensitivity than does photopic (bright light) vision, because the component purples in the rods and cones absorb differently. This fact underlies the Purkinje phenomenon.

A second problem is the question of dark-adaptation. "It is the physical manifestation of bleaching and synthesis of the pigments." A slide of the variation in sensitivity of the eye as it becomes dark-adapted was illuminating, showing that the cones gain sensitivity and approach an asymptotic level quite quickly, while the rods take nearly 45 minutes to develop their maximum. Analysis of the eye shows that these are the growth curves of, respectively, iodopsin and rhodopsin in the cone and rods.

A plot of the log of the sensitivity (reciprocal of threshold) against the concentration of pigment is a straight line.

A slide of the effect of vitamin A deprivation on scotopic vision showed the dramatic character of the recovery of this vision when the vitamin is restored to the diet.

The third problem is the mechanism of conversion of light to nervous excitation: What happens? By dissolving rhodopsin in a glycerol-water mixture and cooling to −80°C the reactions are so slowed down that the individual steps can be followed. Light converts the rhodopsin to lumidopsin, which persists until warmed to 23°, when it splits into half retinene and half recreated rhodopsin, losing color in so doing. This behaviour is reminiscent of the photographic plate, with its latent image: bleaching is a dark reaction, light produces only the latent image. The bleaching is a restoring reaction and probably the conversion to lumidopsin produces the excitation.

For rhodopsin 45 KCal/mole is the bleaching energy, and one mole of 600 mμ are needed to bleach it. There is no temperature coefficient for this reaction as long as the light is of shorter wavelength than this, but above this limit there is a constantly falling sensitivity as more and more energy is required to help the quanta excite the rhodopsin.

Parenthetically, there are no real limits to the sensitivity of the eye: the 4000 to 7000 Å limits merely express an average, the sensitivity out in the red falls continuously.

It is clear from all this that the photochemical theory is not dead.

By using a water model of the human eye the speaker had demonstrated that bleaching a small amount of this pigment raises the threshold greatly: specifically, with 006% bleached, the threshold was up by 8.6 times. Most adaptation seems to depend on the first little bit bleached, or the last bit of pigment reconstructed.

A slide of the cone structure in the Perch eye showed that the layers of pigment—rhodopsin—are exactly one molecule thick: 41 Å being their thickness and equalling the diameter of the molecule. Other eyes have layers twice, and four times this. How can just one quantum stimulate such a structure? This is still an undecided question, and the speaker spent some time examining the possibilities.

The symposium has made real contributions to our understanding of the eye. The facts are clear: "The quantum demand for excitation rises in light adaptation" and "The concentration of pigment is proportional to the logarithm of the sensitivity".

Messrs. Baumgardt, Jones and Potter took part in the discussion, as did several others. It was pointed out that the reactions are all in the solid state: that all of the layers in a cone are equally sensitive, except for a certain amount of filtering; and that we don't really know what happens when the "light goes off". The eye is in a sense like a geiger counter, or scintillation counter, in that one quantum can set it off, and to speak of a threshold in such a case is perhaps misleading. (*Secretary's abstract.*)